Final Wetland and Stream Mitigation Plan

TOP OF LEWISTON HILL TO THORN CREEK ROAD

ITD Project No.: NH-4110(133)
Key No.: 7769 (Lead Project No.)

PROJECT NO. NH-4110(142); KEY NO. 8352
PROJECT NO. NH-4110(141); KEY NO. 8351
PROJECT NO. NH-4110(140); KEY NO. 8350

Prepared for

Idaho Transportation Department, District 2

December 18, 2003

FINAL WETLAND AND STREAM MITIGATION PLAN

Summary

The final wetland and stream mitigation plan was developed from several draft plans as follows:

- The original project Environmental Assessment included Appendix H, which was a conceptual mitigation plan based on use of property from two landowners. One of these landowners decided not to allow their property to be used for a mitigation site.
- The original concept plan was revised to provide wetland mitigation further upstream on the property of the one cooperating landowner. This plan did not consider stream restoration. The revised plan was reviewed by the Army Corps of Engineers and the US Environmental Protection Agency.
- This document, the Final Wetland and Stream Mitigation Plan, added stream restoration.

The proposed project will replace the existing two-lane facility along US 95 with a four-lane, divided highway. Facilities for bicycle or pedestrian traffic are not included. The project is defined as two segments: Top of Lewiston Hill to Genesee beginning at Mile Post (MP) 319.84 and ending at MP 330.98 and Genesee to Moscow beginning at MP 330.98 and ending at MP 343.98.

Project limits (Logical Termini) for the original project have changed from the above-stated mile posts. This change was brought about by a United States District Court decision made on September 19, 2003, in which the northern 4.6 miles of the Genesee to Moscow project was enjoined. On November 5, 2003, the United States District Court wrote a judgment clarification which found that the FHWA may authorize the Highway 95 Top of Lewiston Hill to Thorn Creek Road project to commence.

As a result there are two separate and individual projects. The northern project will begin at Thorn Creek Road (MP 337.2) and extend to Moscow (MP 344.0). The south project will begin at the Top of Lewiston Hill (MP 323.2) and extend north to Thorn Creek Road (MP 337.2). There are no

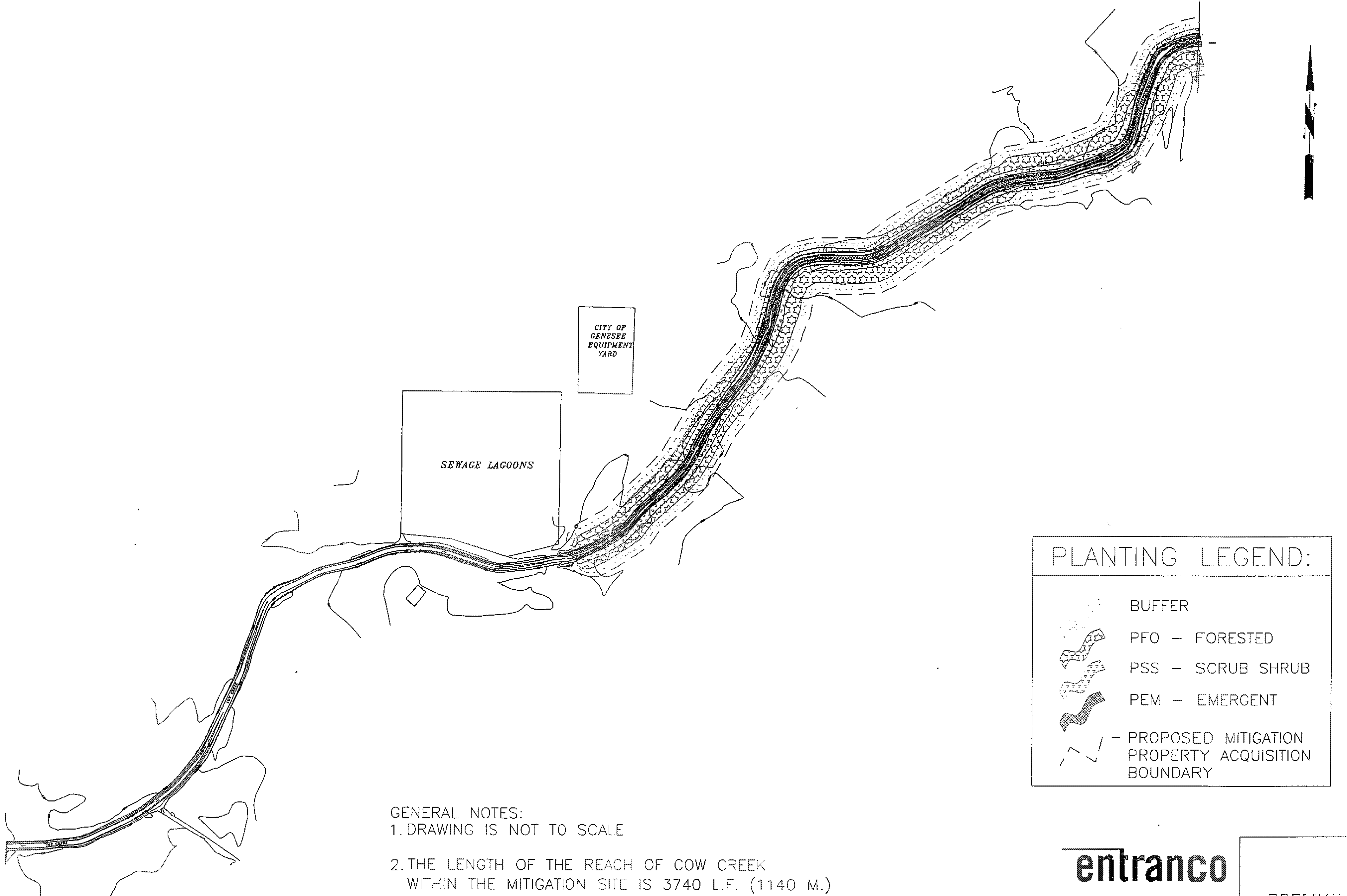
Water Act. The impacts to jurisdictional wetlands total 3.2 acres. The Federal Highway Administration (FHWA) requires mitigation for all wetlands affected by projects sponsored by the agency. Therefore, FHWA will require mitigation for all 3.5 acres filled by Alternative 6. The ratio of wetland replacement will be at least 1:1 for palustrine (freshwater) emergent Category IV wetlands, at least 2:1 for palustrine scrub-shrub Category III wetlands, and at least 5:1 for palustrine forested Category III wetlands.

The wetlands along Alternative 10A included both disturbed and relatively undisturbed areas. Cropland or lands in conservation status generally surround the wetlands. The wetlands downstream of tilled land are subject to high levels of fertilizers and other chemicals used in farming. Alternative 10A will bring vehicle traffic into an area where none exists and will increase the pollutant load on these wetlands from oil and gasoline spilled on the road. Wetland impacts total 5.03 acres. This total includes wetlands that are subject to jurisdiction by the Corps and those that are non-jurisdictional. Impacts to jurisdictional wetlands total 4.9 acres. The FHWA requires mitigation for all wetlands affected by projects sponsored by the agency. Therefore, FHWA will require mitigation for all 5.03 acres filled by Alternative 10A. The ratio of wetland replacement will be at least 1:1 for palustrine emergent Category IV wetlands, at least 2:1 for palustrine scrub-shrub Category III wetlands, and at least 5:1 for palustrine forested Category III wetlands (Figures S-1 and S-2).

In addition, impacts for two adjacent, but separate, FHWA projects will be mitigated as part of this project. The South Fork Palouse River Bridge and South Fork Palouse River Bridge to Sweet Avenue projects, located south of Moscow, Idaho, will affect four wetlands. Two wetlands are on the east side of US 95 and two are on the west side. Wetland impacts total approximately 0.5 acre. These wetlands are not under Corps jurisdiction (N. Braspennickx, personal communication).

The mitigation plan will enhance 2.02 acres of palustrine emergent (PEM) wetland. The plan also includes creation of 3.98 acres of palustrine scrub/shrub (PSS) and 7.51 acres of palustrine forested (PFO) wetland; a total of 11.49 acres of wetland creation. The mitigation requirements for Alternative 10A require 9.50 acres of creation (see table 4): 3.93 acres of PEM, 4.99 acres of PFO and 0.57 acre of non-jurisdictional wetlands, based on impacts to these types of wetland. No PSS wetlands are being impacted; therefore, no PSS creation is required for mitigation.

The Cow Creek site provides an excellent opportunity to enhance the existing PEM wetlands along the stream corridor. Presently, wetlands along the stream are dominated by reed canarygrass. Mitigation plantings will add diversity that will enhance the overall functions and values of the wetlands. Over time, riparian plantings will shade the stream and wetlands and will



PLANTING LEGEND:

- BUFFER
- PFO – FORESTED
- PSS – SCRUB SHRUB
- PEM – EMERGENT
- PROPOSED MITIGATION PROPERTY ACQUISITION BOUNDARY

GENERAL NOTES:
1. DRAWING IS NOT TO SCALE
2. THE LENGTH OF THE REACH OF COW CREEK WITHIN THE MITIGATION SITE IS 3740 L.F. (1140 M.)

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IDAHO TRANSPORTATION DEPARTMENT

FEDERAL AID PROJECT NO.	WETLAND MITIGATION	metric
NH-4110(133)	US-95 TOP OF LEWISTON HILL TO MOSCOW VICINITY MAP	COUNTY LATAH/NEZ PERCE KEY NUMBER 7769 FIGURE S1

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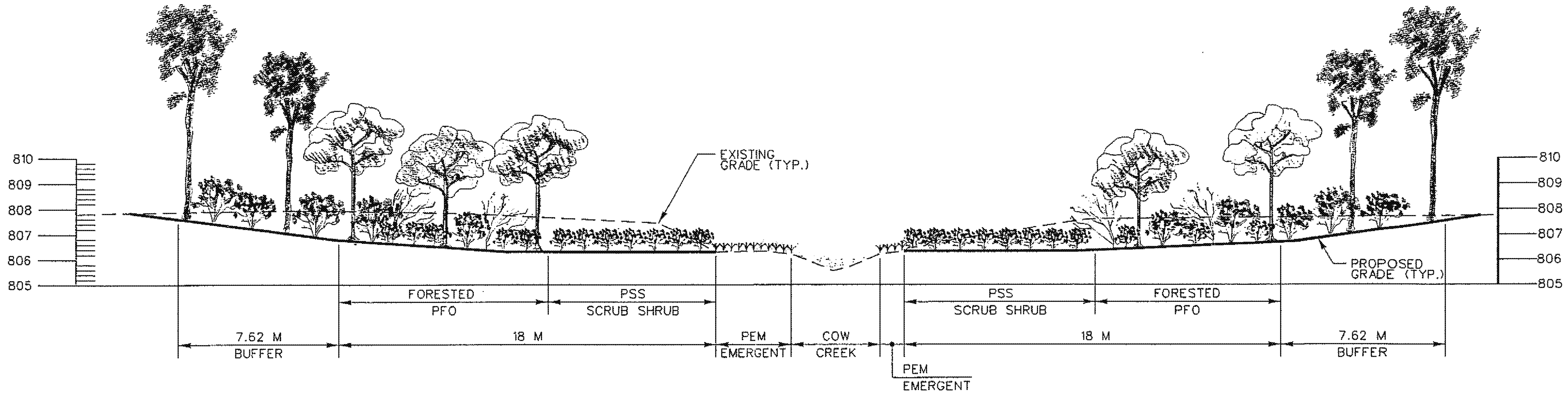

SECTION A-A

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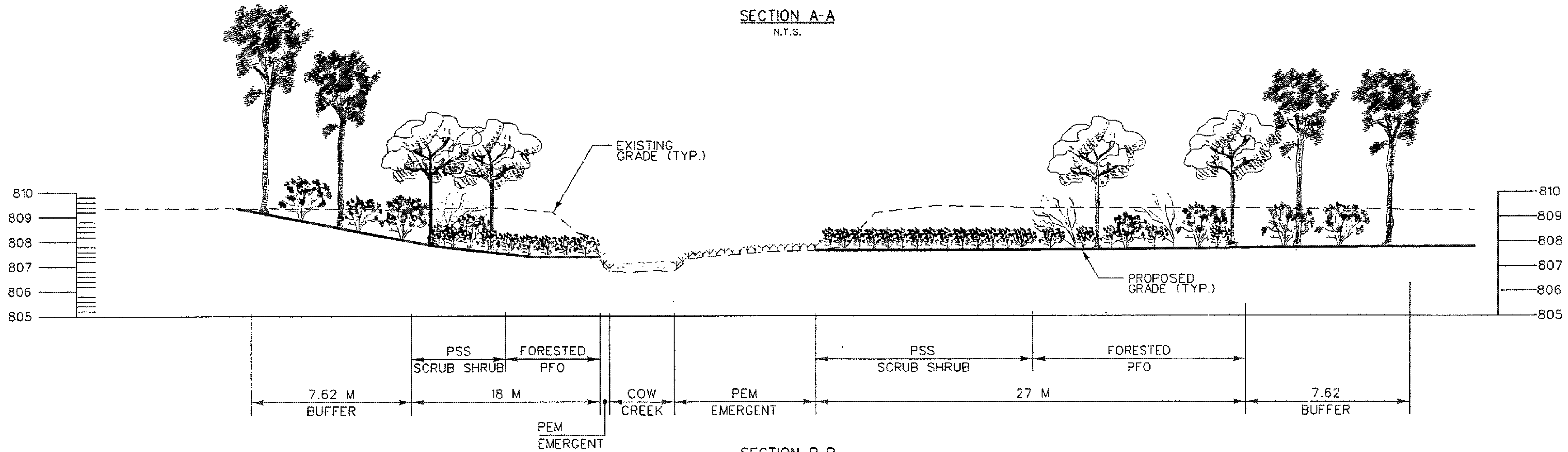

SECTION B-B

N.T.S.

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IDAHO TRANSPORTATION DEPARTMENT

FEDERAL AID PROJECT NO.
NH-4110(133)

WETLAND MITIGATION

US-95
TOP OF LEWISTON HILL TO MOSCOW
CROSS SECTIONS

METRIC

COUNTY
LATAH/NEZ PERCE

KEY NUMBER
7769

Figure S-2

PRELIMINARY
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CONSTRUCTION

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WETLAND MITIGATION PLAN

Project Description

The proposed roadway project will replace an existing two-lane facility along US 95 with a four-lane, divided highway. Facilities for bicycle or pedestrian traffic are not included.

The project is defined as two segments:

- Top of Lewiston Hill to Genesee beginning at Mile Post (MP) 319.84 and ending at MP 330.98
- Genesee to Moscow beginning at MP 330.98 and ending at MP 343.982.

The Lewiston Hill to Genesee segment would reconstruct 7.6 miles of US 95. The Genesee to Moscow segment would reconstruct 12 miles of US 95.

Two alternatives (6 and 10A) were considered for a preferred alternative decision (figure 1). Alternative 10A has been selected for construction. The original Wetland Mitigation Plan, published in Appendix H of the Environmental Assessment, has been revised due to a change in the available land parcels for the proposed wetland mitigation. Alternatives 6 and 10A have a common road segment from the top of the Lewiston Hill north to the interchange at Genesee and continuing further north to a location about 4 miles south of Moscow.

The northern 4 miles of the project followed two different alignments. Alternative 6 followed the existing highway north to Moscow. Alternative 10A, however, diverts northeast of the existing highway at Reisenauer Hill and runs north along the west side of Paradise Ridge. The alignment reconnects to the existing highway just south of the South Fork Palouse River Bridge near Moscow.

To compensate for unavoidable wetland impacts along Alternative 10A, approximately 11.49 acres of created wetlands and 2.02 acres of enhanced wetlands are proposed in the Cow Creek floodplain upstream of the US 95 crossing. The mitigation area will create wetlands within the floodplain of Cow Creek, to compensate for impacts resulting from agriculture, draining, and dredging practices. To mitigate for project impacts and to add habitat diversity, the wetland mitigation plan includes areas of forested, scrub-shrub, emergent, and open-water wetland types.

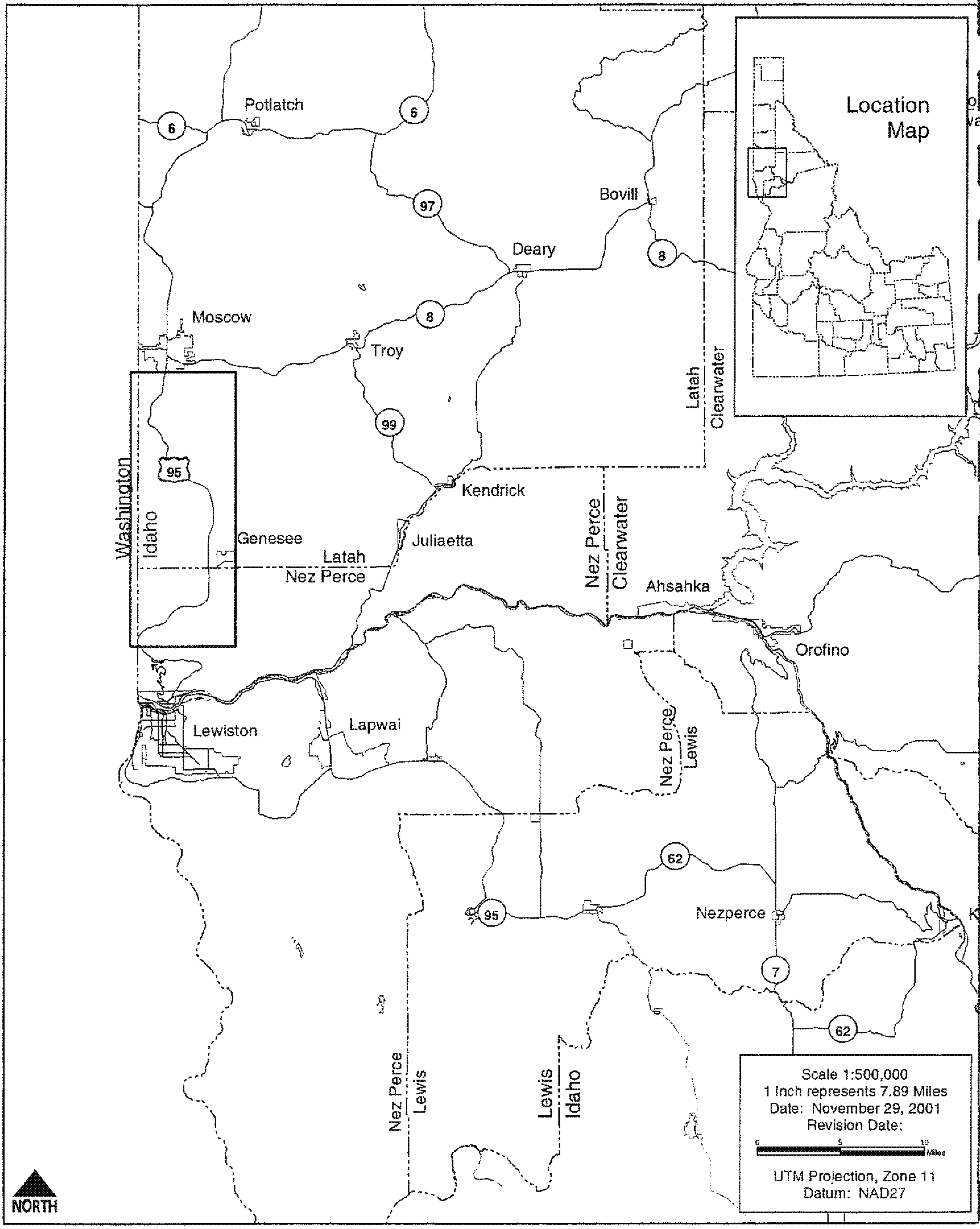

Figure 1
State Location Map

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One important aspect of the wetland mitigation was to evaluate the potential interaction between Cow Creek flows and the wetland mitigation floodplain area. A review of watershed hydrology revealed that large flows and flooding are a common occurrence at the project site. The large stream flows often occur with rain-on-snow events in the winter and spring.

The mitigation design effort has evaluated the floodplain hydraulic effects of the large stream flows and provided features to minimize scour and erosion. Specific measures in the wetland mitigation floodplain area include:

- Re-establishment of a floodplain area through excavation.
- Placement of rock vanes to direct high flood flows through the project area
- Protection of the upstream and downstream bridges from high flow velocities. These bridges are the upstream and downstream boundaries of the mitigation project.

Stream bank stability will improve as a result of the mitigation project. The riparian zone will have greater species diversity, and the stream will be shaded, thereby improving water quality in Cow Creek.

Purpose and Need

The purpose of the roadway project is to improve public safety and increase highway capacity on US 95 between the top of Lewiston Hill and South Fork Palouse River Bridge, south of Moscow.

The portion of the existing US 95 within the project limits, does not meet current American Association of State Highway and Transportation Officials Standards. Deficiencies have been identified as width, clear zones, grade, horizontal and vertical curves, and sight distance. Additional concerns include high-accident locations, access control, and insufficient highway capacity.

The wetland creation and stream enhancement project is intended to compensate for unavoidable wetland impacts during road construction. This report outlines the project impacts, presents the goals and objectives of the mitigation plans, provides contingency measures, and suggests monitoring and maintenance measures.

Existing Conditions

Cow Creek

The mitigation site is adjacent to Cow Creek, southwest of the city of Genesee, Idaho. Cow Creek, a perennial stream, drains a 36.5-square-mile area in southern Latah County and northern Nez Perce County in northern Idaho (D. Busko, personal communication). The stream originates on Paradise Ridge, south of Moscow, Idaho. From the headwaters, the stream flows south through the Palouse region into the town of Genesee. From Genesee, the stream flows to the west to Union Flat Creek, one mile from the Idaho-Washington border. The Palouse region in eastern Washington and northern Idaho is an area of very rich loess soils and is productive farmland. Dry land agriculture dominates land use, and crops, such as wheat and peas, grow well in the fertile loess soils of the Cow Creek valley and surrounding hills.

Initially, the mitigation plan spanned two properties and extended from the existing highway eastward to the Tamarack Street/Krier Road Bridge. The westernmost property was not considered accessible because the landowner refused to sign the right of entry agreement. The Idaho Transportation Department (ITD) and Entranco agreed to change the project's scope of work to include only the eastern property, which belongs to the Becker family. Another property was added to the project, however. Dale Becker offered a 6-acre parcel along Morscheck Road as a possible purchase property for ITD. All investigation and planning efforts were refocused to the properties between the Morscheck Road Bridge and the Tamarack Street/Krier Road Bridge.

The reach of Cow Creek associated with the proposed wetland mitigation has been channelized, and the hydrology has been deeply impacted by agricultural activities. The channel itself has been incised into loess and clay to depths of 2 to 3 meters. Records of a gaging station upstream of the project area show that the base flow is very low, on the order of 0.1 to 0.3 cms (5 to 10 cfs), but that much higher flows occur on a regular recurrence interval. The larger events tend to be "flashy," with flows nearing 28 cms (1,000 cfs) during the period of record. The larger flows have resulted in significant and active erosion of the sides of the channel, which are nearly vertical along the entire reach.

Cow Creek has been impacted over the last 100 years by the loss of native vegetation, along with the overwhelming transition of land uses from prairie to tilled agricultural ground. The most obvious impacts are unusual stream bank instability and a very high suspended sediment load. In addition, the area near the sewage lagoon appears to be influenced not only by surface water inflow, but by groundwater inflow as well.

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The Cow Creek watershed is predominately rural, and land use is mostly agricultural. Some area is pasture for grazing small herds of livestock. The town of Genesee is the only incorporated city in the watershed. Groundwater is the only source of drinking water for people living in the Cow Creek watershed (Strausz 2001).

Genesee was once a fairly active town with many businesses that supported local farmers. The town has since also become a bedroom community for nearby larger cities on the Palouse; its population is approximately 1,000 residents. The town of Genesee treats its municipal wastewater in a lagoon located southwest of town, just north of Cow Creek. This lagoon lies just beyond the downstream terminus of the mitigation site. Most rural residents in this area treat their wastewater using septic systems and drain fields (Strausz 2001).

Intermittent and ephemeral streams drain most of the area; however, some streams flow perennially due to discharge from aquifers (Omernik and Gallant, 1986). Natural vegetation consists primarily of grass and sagebrush, with forests on higher slopes. Small trees and brush grow around springs where water is more plentiful. The Cow Creek area supports agriculture in the form of wheat, barley, and legume crops including peas, lentils, and garbanzos. The Palouse region is extraordinarily productive due to timely rainfall and unusually rich soils. The Cow Creek watershed lies on the eastern portion of the Columbia Basin ecoregion, an area that receives more rainfall than most of the ecoregion (Omernik and Gallant, 1986).

US 95 Corridor

Most of the proposed roadway project traverses agricultural land. The general landscape of the study corridor is foothills on the east, and open, rolling terrain to the west. Near the middle of Alternative 6, US 95 passes just west of the town of Genesee. Land ownership is predominantly private.

The portion of Alternative 10A from Reisenauer Hill to Moscow cuts across country to the west of Paradise Ridge. While the alignment crosses mostly crop land, several vegetated drainages covered in trees and shrubs come down from Paradise Ridge. These areas provide substantial habitat and offer migration corridors for wildlife. Alternative 10A would intercept these drainages and interrupt these corridors.

Jurisdictional waters of the United States (waters), including wetlands, as regulated by the U.S. Army Corps of Engineers (Corps) were delineated within the study corridors. The waters are primarily in the form of natural drainages with associated wetlands and isolated wetlands. The wetland delineation followed routine delineation methods described in the *Corps of*

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Engineers Wetlands Delineation Manual, 1987. The delineation findings were published in *Waters of the United States Identification, US 95, Top of Lewiston Hill to Moscow* (Entranco 2000). The wetlands by proposed alignment are shown in figure 2.

Vegetation

US 95 Corridor

The vegetation in the existing roadside wetlands was predominately reed canarygrass (*Phalaris arundinacea,* OBL), cattail (*Typha latifolia,* OBL), rush (*Juncus* spp., FACW), plantain (*Plantago* spp., FACW), curly dock (*Rumex crispus,* FACW), meadow foxtail (*Alopecurus pratensis,* FACW), and willow (*Salix* spp., FACW). Douglas hawthorn (*Crataegus douglasii,* FAC), clover (*Trifolium* spp., FAC), bentgrass (*Agrostis* spp., FAC), and cow-parsnip (*Heracleum lanatum,* FAC) were found in the less disturbed existing wetlands along Alternative 10A.

Upland plants surrounding these wetlands included wheatgrass (*Agropyron* spp., FACU), fescue (*Festuca* spp., FACU), timothy (*Phleum pratense,* FACU), bluegrass (*Poa* spp., FACU), and brome (*Bromus* spp., FACU).

Cow Creek

Cow Creek has been impacted over the last 100 years by the loss of native vegetation, along with the overwhelming transition of the land use from prairie to tilled agricultural ground. The stream banks and floodplain of Cow Creek are currently dominated by reed canarygrass and cattail.

Soils

Three major soil groups are found in the Cow Creek watershed. The primary soil group is the Palouse-Naff soil group. The other two soil groups, the Latahco-Lovell and Palouse Silt Loam groups, occur less frequently. Soil variation in the Cow Creek area is primarily due to changing landforms. The uplands and lowlands in the area are a result of the stream winding through the Palouse region. The lowlands in the valley of Cow Creek constitute the floodplain. The soils in the floodplain are primarily of the Latahco-Lovell group with small quantities of Palouse Silt Loam soils. These soils, especially the Latahco-Lovell soil, generally occur in flat areas. The uplands surrounding the stream, composing most of the watershed, primarily have soils in the Palouse-Naff soil group (USDA SCS 1981). The characteristics of soil groups found in the area are discussed below.

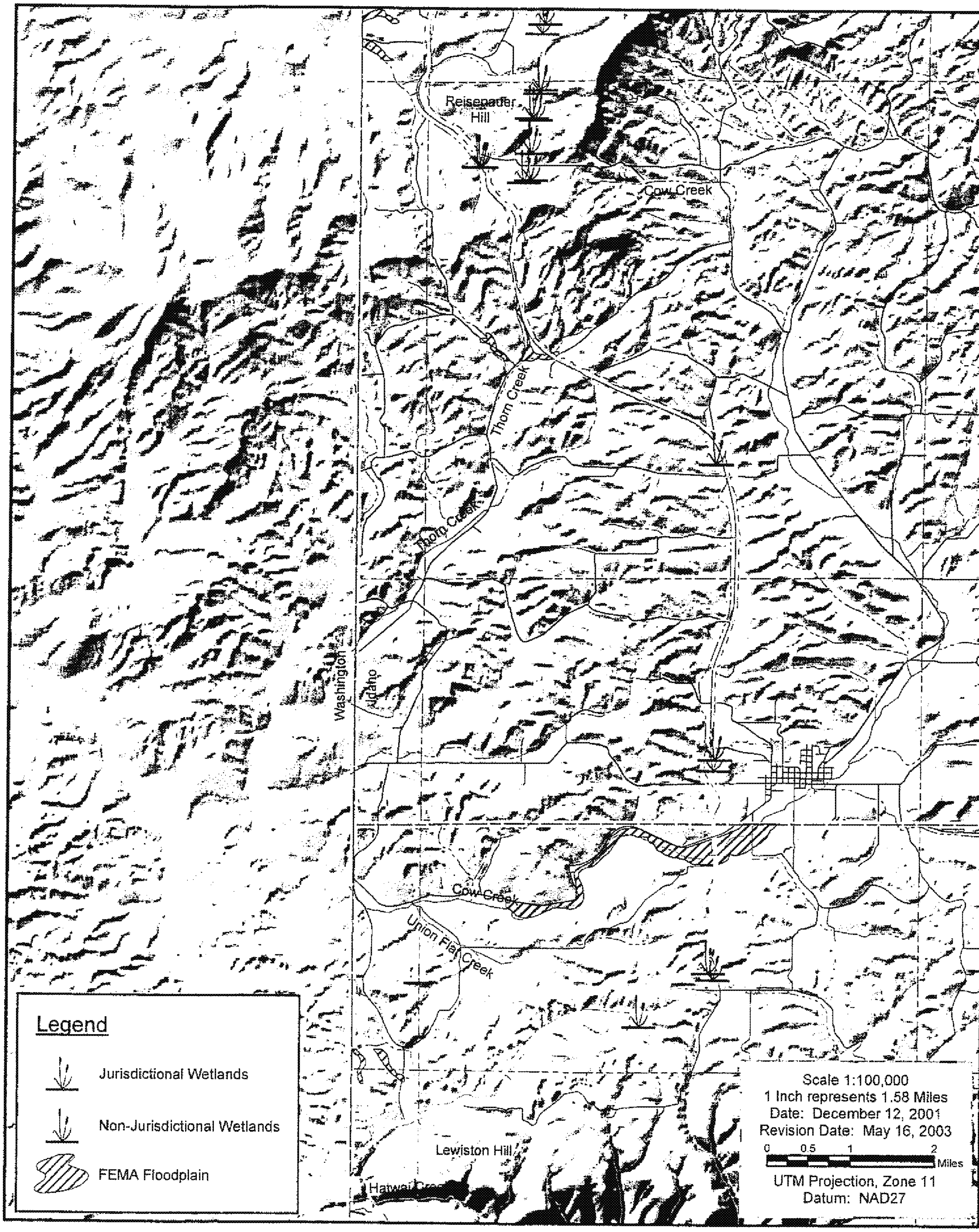

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Figure 2
Location of Wetlands and Floodplains Along Project Corridors

- Palouse-Naff soil group: These very deep, well-drained soils occur on gently sloping to moderately sloping landscapes. These soils are generally formed from a loess base (USDA SCS 1981).

- Latahco-Lovell soils: These very deep and somewhat poorly drained soils are formed from alluvium. Permeability is moderately slow. Available water capacity is high. Soil is usually subject to brief periods of flooding in the winter and spring seasons (USDA SCS 1981).

- Palouse Silt Loam soil: A very deep soil that is well drained and usually lies on the south slopes of uplands. Soil is formed from loess. Permeability is moderate, and the soil has a high available water capacity. Runoff is usually rapid, thus increasing the hazard of soil erosion (USDA SCS 1981).

Soil samples were collected and examined during the installation of ten piezometers in the project area, as shown on figure 3.

The soil profiles were consistent across the site, although thicknesses of the various substrate materials varied somewhat from place to place. The profile consisted of an upper stratum of dark brown to dark grayish brown, fine-grained soil, probably loess. The upper layer varied in thickness from 3 to 7 feet. Underlying the loess is a stiff clay, which is commonly yellowish tan or reddish tan in color at the top, indicating that it is oxidized. The clay grades to a more tan color with depth. The clay may belong to the Latah formation, which consists of fine-grained sediments deposited atop basalt flows during the Miocene (22.5 to 5 million years ago). Underlying the stiff clay are sand, pebbles and cobbles in a clay matrix. With depth, this stratum becomes rockier. The coarse fragments are composed of basalt. This gravel-rich layer is generally only 2 or 3 feet thick, and grades with depth to basalt bedrock.

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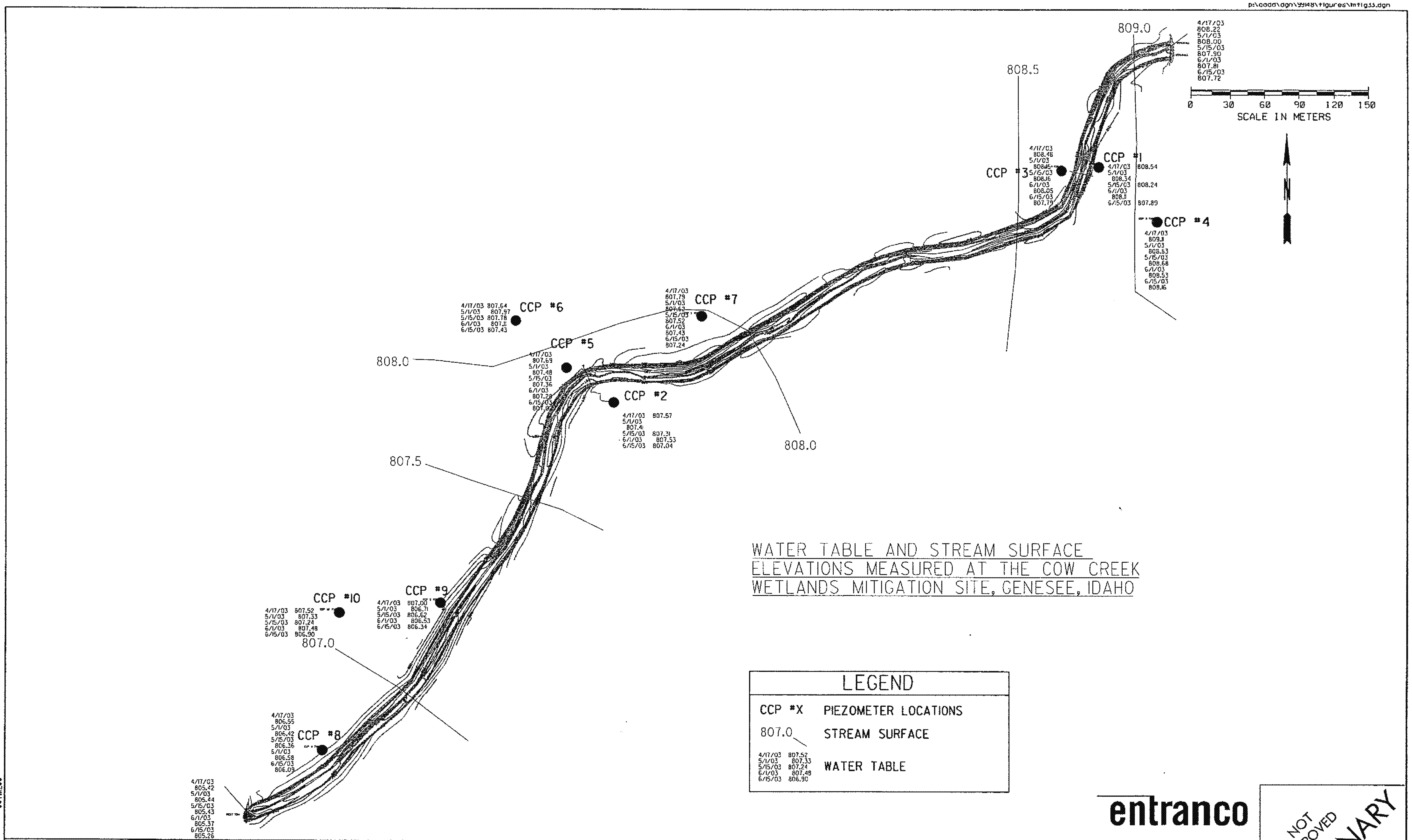

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NO.	DATE	BY	DESCRIPTION			NH-4110(133)	US-95 TOP OF LEWISTON HILL TO MOSCOW PIEZOMETER LOCATIONS	COUNTY LATAH/NEZ PERCE
			DESIGN CHECKED					KEY NUMBER 7769
			DETAILED	CADD FILE NAME				
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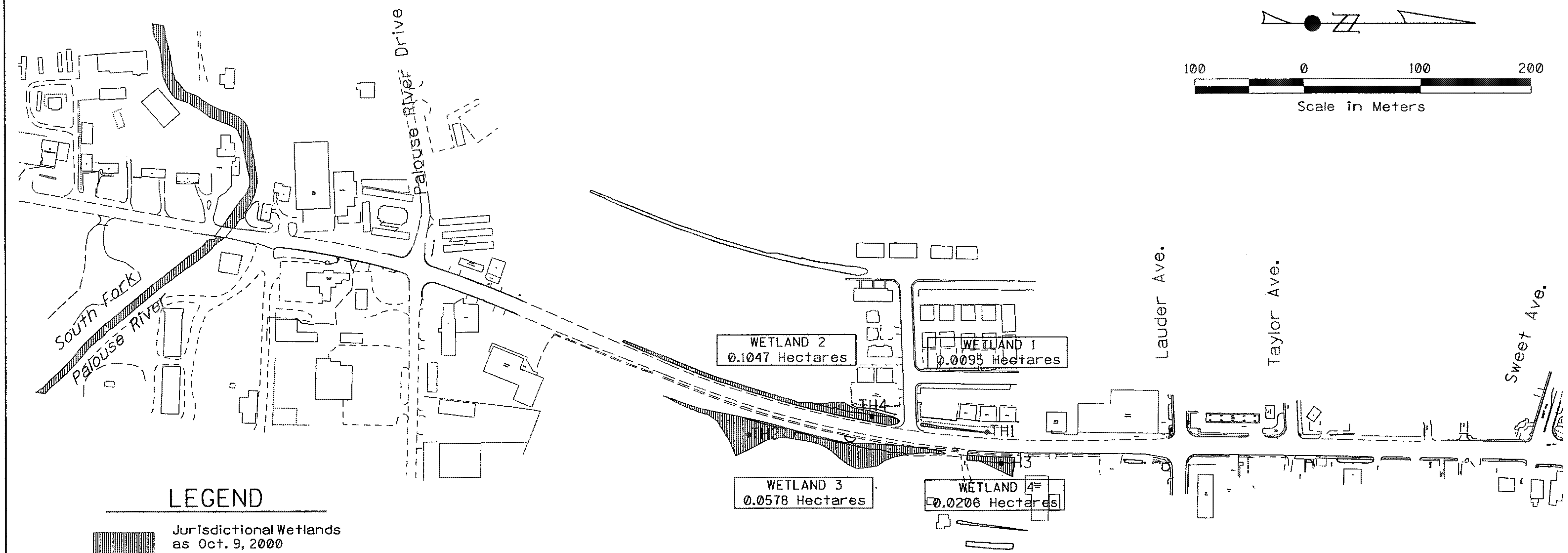

LEGEND

Jurisdictional Wetlands as Oct. 9, 2000 (Total 0.8562 Hectares)

Jurisdictional Waters

TH 1 Soil Test Holes

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IDAHO TRANSPORTATION DEPARTMENT

FEDERAL AID PROJECT NO. NH-4110(133)

WETLAND MITIGATION

US-95
TOP OF LEWISTON HILL TO MOSCOW
WETLAND IMPACTS ON MOSCOW SOUTH

metric

COUNTY LATAH/NEZ PERCE

KEY NUMBER 7769

FIGURE 6

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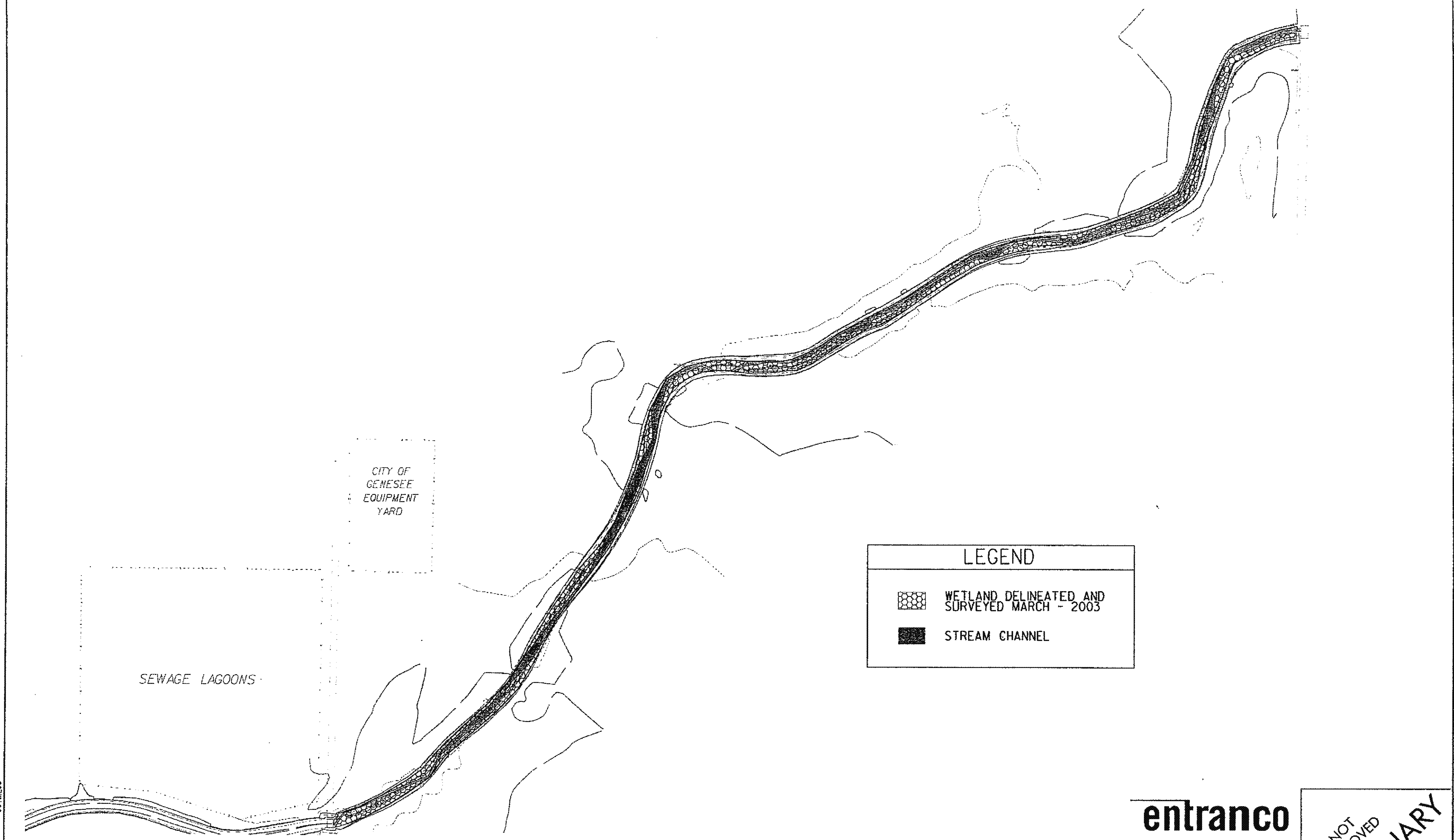

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IDAHO TRANSPORTATION DEPARTMENT

FEDERAL AID PROJECT NO.
NH-4110(133)

WETLAND MITIGATION
US-95
TOP OF LEWISTON HILL TO MOSCOW
COW CREEK WETLANDS ON THE MITIGATION SITE

metric
COUNTY
LATAH/NEZ PERCE
KEY NUMBER
7769
FIGURE 7

12/19/2003

Hydrology

US 95 Corridor

Hydrology within the existing wetlands along the road corridor ranged from dry to saturated to the surface. Some isolated roadside wetlands exhibited dry soil pit conditions, likely because test excavations took place during late summer. The hydrology at most of the wetlands is driven by a combination of groundwater and roadside runoff channeled through roadside ditches and drainages.

Thirty-five drainages were identified within the project study area along alternatives 6 and 10A. Most of the drainages along US 95 cross under the road in culverts. The direction of flow varies with the local topography. Thirty-five wetlands occur within the right-of-way (ROW) for alignments 6 and 10A; all but eight of these are jurisdictional.

Cow Creek

Surface Water

The Cow Creek drainage covers 36.5 square miles from the south end of Paradise Ridge, southeast of Moscow, Idaho, to a point in Washington southwest of Genesee, Idaho. Most land within the drainage is dedicated to agricultural production, primarily dryland grains and legumes. Large tracts of tillage or fallowing in the Palouse soils provide a large sink for precipitation. Low-recurrence runoff events are large, flashy, and widely spaced temporally. An analysis of the hydrology of the system is provided in Appendix C (Review of Hydrologic Data). The analysis was based on discharge recurrence values developed for Idaho. Flow data are also available for a 6-year period between October 1, 1979, and September 30, 1986. These data confirm the higher discharge flow events. These larger events ranged from 3 to over 27 cubic meters per second (cms) (110 to 970 cubic feet per second [cfs]) with durations from one to five days. Base flow ranged from 0 to about 1 cms (0 to 35 cfs) over the remainder of the time at that gage. The higher-flow discharges all occurred during February or early March and appear to be associated with rain-on-snow events.

Groundwater

Ten piezometers (CCP 1 through 10; Figures 4a – 4j) were installed within the mitigation project area to determine the quantity and location of groundwater available to support the proposed wetlands. Three piezometers were installed on the south side of Cow Creek and seven were installed on the north side (figure 3). The piezometers were constructed using 1 ¼-inch-diameter Schedule

LOG OF BORING CCP-1

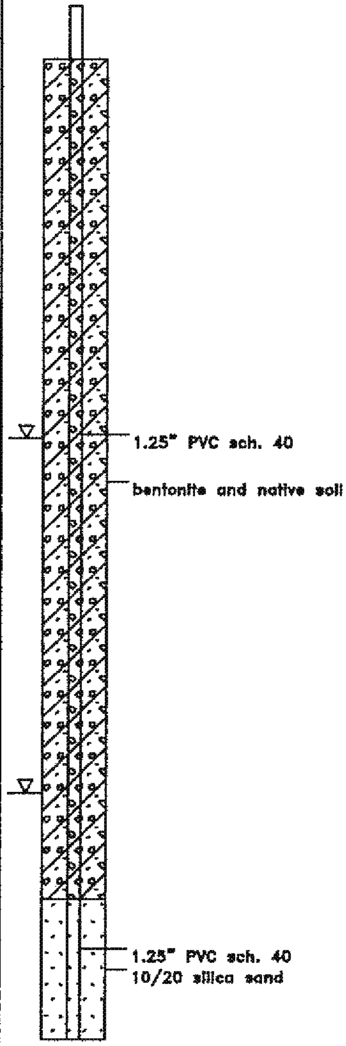
entranco
2030 11TH AVE., SUITE 11
HELENA, MONTANA 59601
(406)449-8627

Project Number	: 80-99148
Date	: 3/18/03
Drilling Firm	: Roach Construction
Drilling Method	: hollow-stem auger
Geologist	: Bruce Siegmund

Figure 4a.

Depth in feet	GRAPHIC	DESCRIPTION	Surf. Elev. 2658.3
0		Loess; brown to grey-brown, silt-dominated soil	2658
2			2656
4			2654
6			2652
8			2650
10		stiff tan clay; more gravel with depth	2648
12			2646
14		basalt; refusal	2644
16			2642
18		high static water level measured 3/19/03 low static water level measured 8/12/03	2640
20			

Well: CCP-1
Elev.:



LOG OF BORING CCP-2

entranco

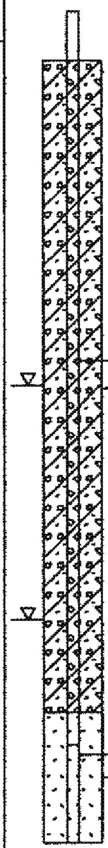
2030 11TH AVE., SUITE 11 HELENA, MONTANA 59601 (406)449-8627

Project Number	:	80-99148
Date	:	3/18/03
Drilling Firm	:	Roach Construction
Drilling Method	:	hollow-stem auger
Geologist	:	Bruce Siegmund

Figure 4b.

Depth in feet	GRAPHIC	DESCRIPTION	Surf. Elev. 2654.92
0		Loess; brown to grey-brown, v. fn-gr soil, very wet	
			2654
2			
			2652
4			
			2650
6			
			2648
8		stiff tan clay; grades at depth to steel gry silt; contains basalt gravel ~11 feet	
		water at 9 - 10 feet	2646
10			
			2644
12		basalt; refusal	
			2642
14			
			2640
16			
			2638
18		high static water level measured 3/19/03 low static water level measured 8/12/03	
			2636
20			

Well: CCP-2
Elev.: 2656.25



LOG OF BORING CCP-3

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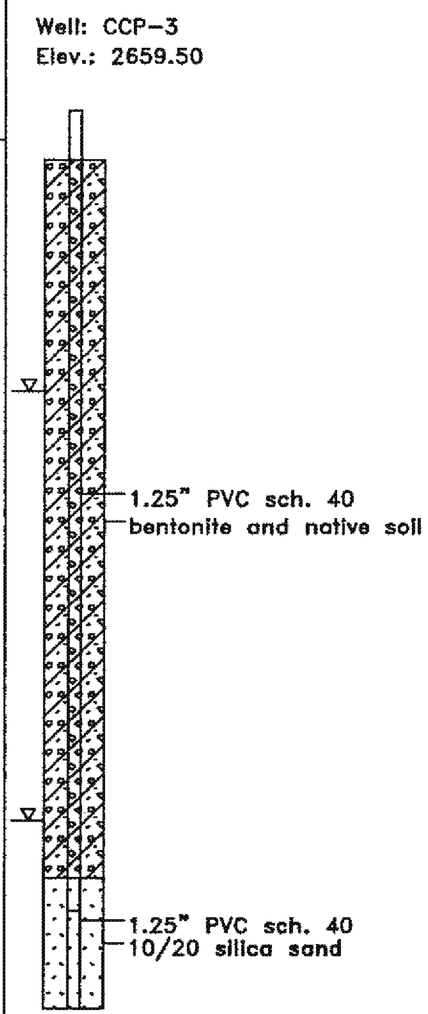
2030 11TH AVE., SUITE 11 HELENA, MONTANA 59601 (406)442-8627

Project Number : 80-99148
Date : 3/18/03
Drilling Firm : Roach Construction
Drilling Method : hollow-stem auger
Geologist : Bruce Siegmund

Figure 4c.

Depth in feet	GRAPHIC	DESCRIPTION	Surf. Elev. 2658.45
0		Loess; brown to grey-brown, damp	2658
2			2656
4			2654
6		stiff tan clay; possibly sandy	2652
8			2650
10			2648
12		grading to darker, steel-gray clay	2646
		basalt; refusal	
14			2644
16			2642
18		high static water level measured 3/19/03 low static water level measured 8/12/03	2640
20			

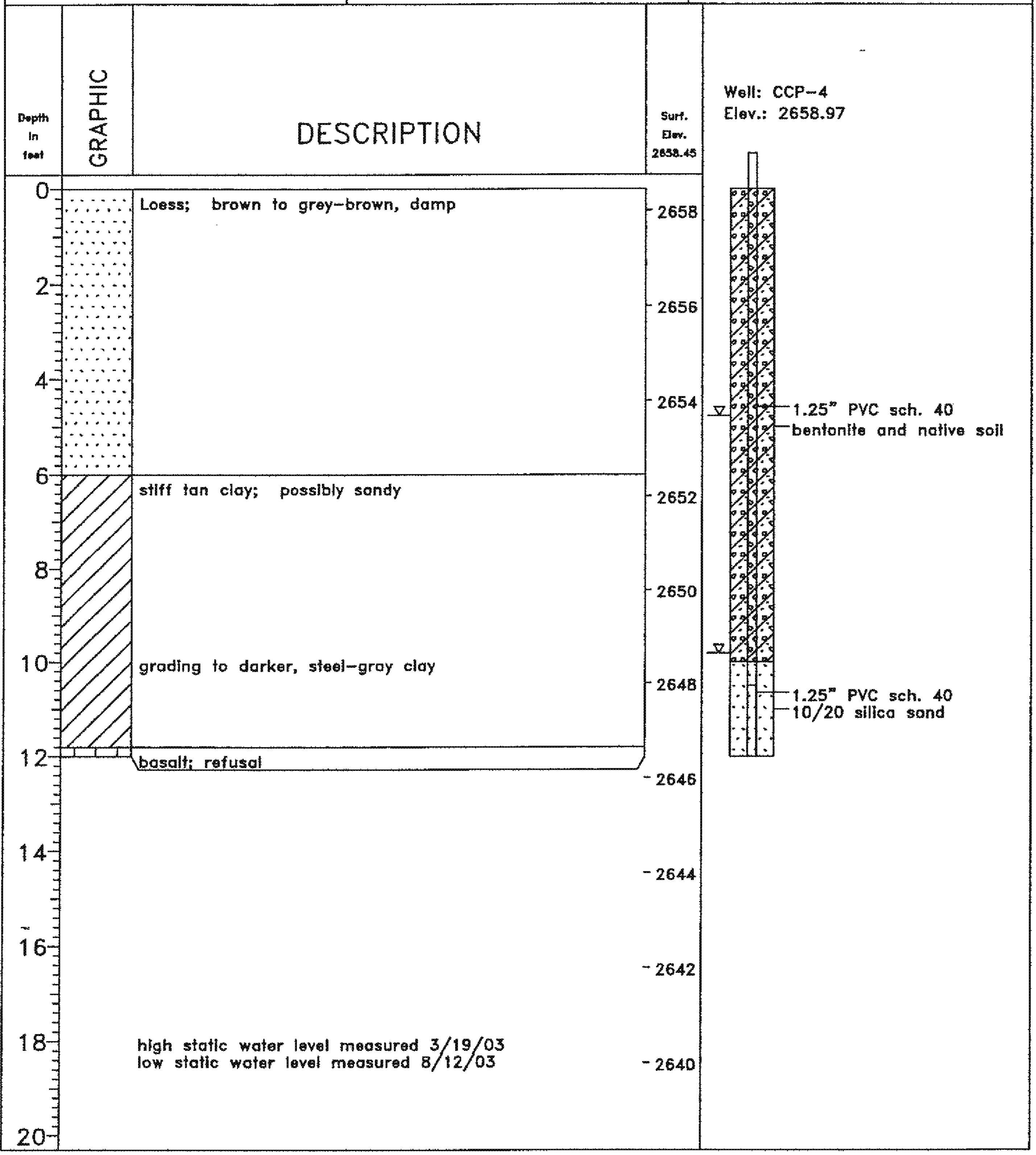


LOG OF BORING CCP-4

entranco

Project Number : 80-99148
Date : 3/18/03
Drilling Firm : Roach Construction
Drilling Method : hollow-stem auger
Geologist : Bruce Siegmund

Figure 4d.



LOG OF BORING CCP-5

entranco

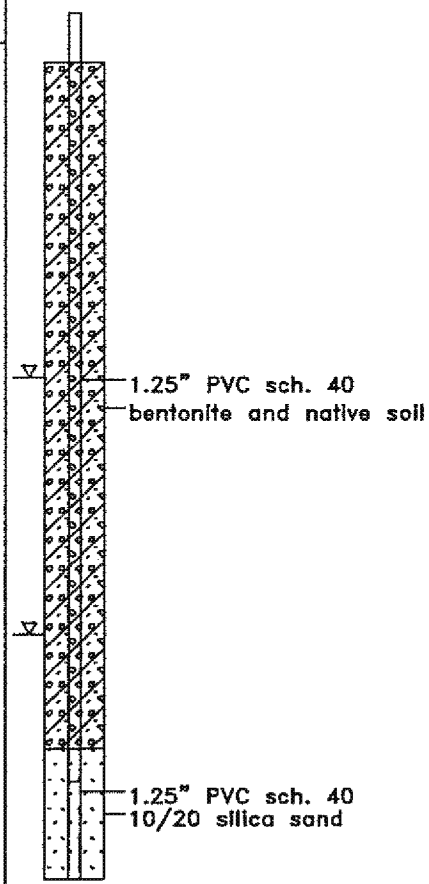
Project Number : 80-99148
Date : 3/18/03
Drilling Firm : Roach Construction
Drilling Method : hollow-stem auger
Geologist : Bruce Siegmund

Figure 4e.

Depth in feet	GRAPHIC	DESCRIPTION	Surf. Elev. 2658.45
0–7		Loess; brown to grey-brown, damp	2658 – 2652
7–12.5		stiff tan clay;	2651
~10		grading to darker, steel-gray clay	2648
12.5		basalt; refusal	2646

high static water level measured 3/19/03
low static water level measured 8/12/03

Well: CCP-5
Elev.: 2656.02



LOG OF BORING CCP-6

entranco
2030 11TH AVE., SUITE 11
HELENA, MONTANA 59601

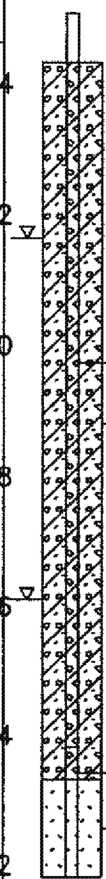
Project Number : 80-99148
Date : 3/19/03
Drilling Firm : Roach Construction
Drilling Method : hollow-stem auger
Geologist : Bruce Siegmund

Figure 4f.

Depth in feet	GRAPHIC	DESCRIPTION	Surf. Elev. 2654.30
0–4		Loess; brown to grey-brown very wet at 4 feet	2654–2650
4–12		steel-grey silt; loess, possibly oxidized grades to tan clay tan and steel-grey clay	2650–2642
12–12.5		weathered basalt bedrock	2642

high static water level measured 3/19/03
low static water level measured 8/12/03

Well: CCP-6
Elev.: 2655.30



LOG OF BORING CCP-7

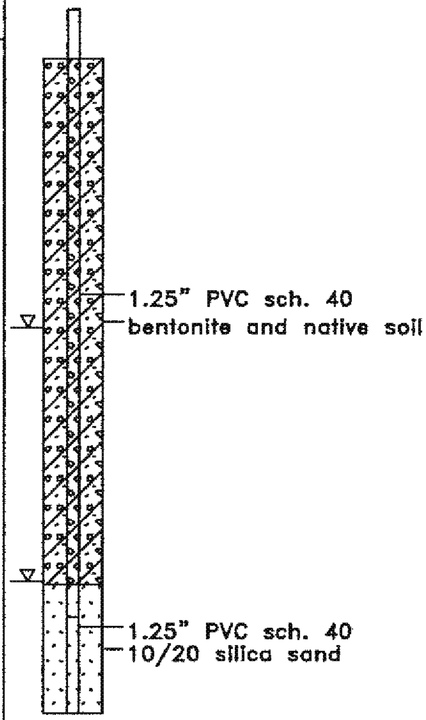
entranco
2530 11TH AVE., SUITE 11 HELENA, MONTANA 59601 (406)449-8627

Project Number : 80-99148
Date : 3/19/03
Drilling Firm : Roach Construction
Drilling Method : hollow-stem auger
Geologist : Bruce Siegmund

Figure 4g.

Depth in feet	GRAPHIC	DESCRIPTION	Surf. Elev. 2657.48
0		Loess; brown to grey-brown	
2			
4		tan clay	2654
6			2652
8		gravel in the clay; decomposed basalt	2650
10		weathered basalt bedrock	2648
12			2646
14			2644
16			2642
18		high static water level measured 3/19/03 low static water level measured 8/12/03	2640
20			2638

Well: CCP-7
Elev.: 2657.48



LOG OF BORING CCP-8

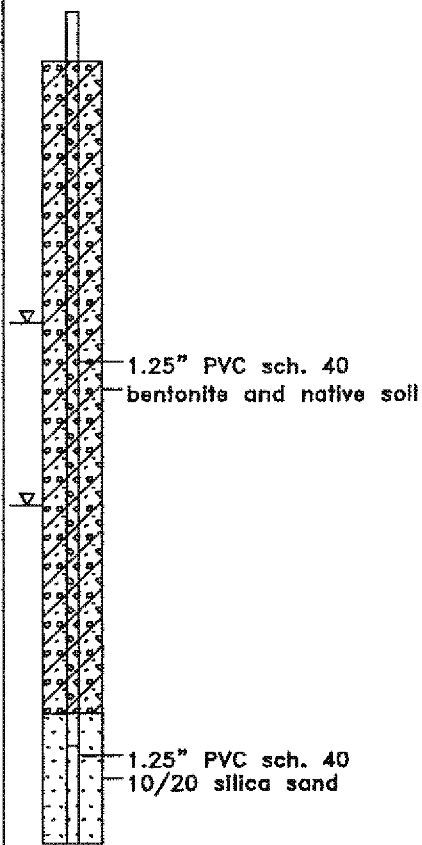
entranco
2030 11TH AVE., SUITE 11 HELENA, MONTANA 59601 (406)449-3627

Project Number : 80-99148
Date : 3/19/03
Drilling Firm : Roach Construction
Drilling Method : hollow-stem auger
Geologist : Bruce Siegmund

Figure 4h.

Depth in feet	GRAPHIC	DESCRIPTION	Surf. Elev. 2652.06
0		Loess; brown to dark brown	2652
2			2650
3		light grey clay then tan clay	
4			2648
6			2646
8		gravel in the clay; some decomposed basalt with depth; oxidized	2644
9		mostly weathered basalt in clay matrix	
10			2642
11.5		weathered basalt bedrock with ample clay	
12			2640
14			2638
16			2636
18		high static water level measured 3/19/03 low static water level measured 8/12/03	2634
20			

Well: CCP-8
Elev.: 2652.06



LOG OF BORING CCP-9

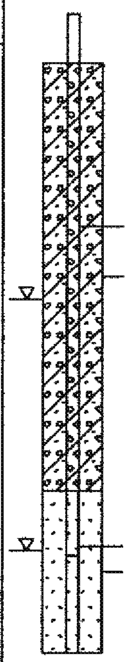
entranco
2030 11TH AVE., SUITE 11 (406)449-8827
HELENA, MONTANA 59601

Project Number : 80-99148
Date : 3/19/03
Drilling Firm : Roach Construction
Drilling Method : hollow-stem auger
Geologist : Bruce Siegmund

Figure 4i.

Depth in feet	GRAPHIC	DESCRIPTION	Surf. Elev. 2651.64
0		Loess; brown to dark brown	
2			2650
4			2648
5		light tan clay; wet	2646
6			
7		decomposed basalt fragments	
8		basalt bedrock	2644
10			2642
12			2640
14			2638
16			2636
18		high static water level measured 3/19/03 low static water level measured 8/12/03	2634
20			2632

Well: CCP-9
Elev.: 2653.22



LOG OF BORING CCP-10

entranco

2030 11TH AVE., SUITE 11
HELENA, MONTANA 59601
(406)449-8827

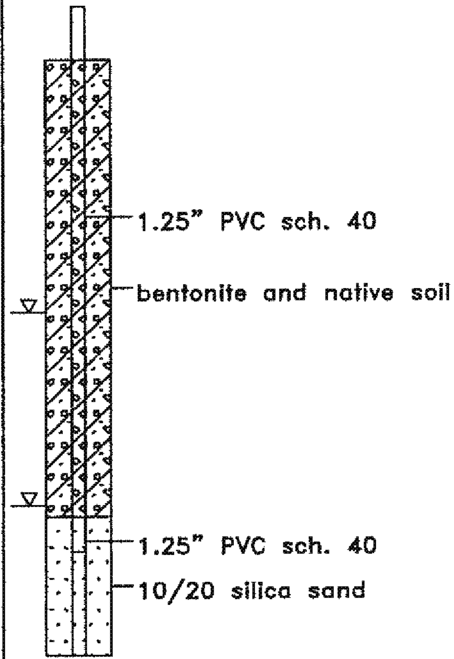
Project Number : 80-99148
Date : 3/19/03
Drilling Firm : Roach Construction
Drilling Method : hollow-stem auger
Geologist : Bruce Siegmund

Figure 4h.

Depth in feet	GRAPHIC	DESCRIPTION	Surf. Elev. 2651.49
0–4		Loess; brown to dark brown	2650, 2648
4–8.2		light tan clay; wet decomposed basalt fragments	2646, 2644
8.2–8.5		basalt bedrock	
10, 12, 14, 16, 18, 20			2642, 2640, 2638, 2636, 2634, 2632

high static water level measured 3/19/03
low static water level measured 8/12/03

Well: CCP-10
Elev.: 2652.82



40 PVC with hand-cut slots on the lowermost 1.5 feet of each pipe. The slotted intervals were wrapped with filter fabric secured with nylon cable ties. The piezometers were completed with 10/20 silica sand as a filter pack to about 6 inches above the screened intervals. Above the filter pack, #5 granular bentonite was used to grout the holes. The piezometers are protected by an outer casing of 4-inch-diameter Schedule 40 ABS pipe. The outer casings have been sunk about a 1.5 feet below the ground surface, with the caps being flush with the tops of the inner casings.

Water levels in the piezometers were measured about a day after completion to allow groundwater to return to equilibrium after drilling. Thereafter ITD initiated a data collection schedule beginning in March 2003 consisting of semi-monthly measurements of the static water level in each piezometer and the stream water surface level at the bridges on either end of the project reach. Data collection will continue through construction, although some of the piezometers will be within the construction area and will have to be removed and possibly replaced. Stream flow velocity was measured periodically at the upstream bridge.

Groundwater was encountered in every boring, occurring at the base of the loess and at the base of the clay near the top of the basalt bedrock. Static water levels were measured at the time of drilling at depths of 0.75 to 1.5 meters below the ground surface (bgs). The shallowest groundwater was found on the western edge of the area on the Dale Becker property. Those locations lie a few hundred feet east of the City of Genesee sewage lagoon, which is reported by the operators to leak several tens of thousands of gallons of effluent daily. The groundwater flow appears to be impacted by this leakage, resulting in a mounding effect, which backs up the groundwater to the east, lowering the hydraulic gradient. It appears that most of the leakage from the lagoons is discharging into Cow Creek, downstream of the project area, and to the subsurface downgradient of the project area.

The data collected to date indicate that the groundwater flow is generally westward and groundwater levels are all higher than the surface of Cow Creek. The initial measurements of the stream level and the groundwater levels in the piezometers indicate that the stream is recharged, at least through a portion of the year, by the groundwater. The very large tracts of tilled and disturbed soil will absorb large percentages of precipitation, and this seepage recharges the groundwater in the valley. Large creek discharge during major watershed runoff events may reverse the groundwater flow interaction with the stream. When this occurs, groundwater levels proximal to the stream are over-topped by the water surface elevation from the stream. Surface water then recharges the groundwater system.

The data from the boreholes, observations of the exposures along the stream, and the static groundwater data all lead to the conclusion that the groundwater is perched atop and/or within the basalt bedrock. The system may be considered as semi-confined by the clay stratum that overlies the basalt, but the clay is clearly perforated by roots and burrowing animal life, which allow for relatively easy infiltration. Again, water can be seen actively flowing from the clay stratum proximal to the sewage lagoons. Groundwater was encountered in every piezometer at an elevation above the top of the clay bed. Thus, for all practical purposes, the loess, clay, and top of the basalt may be considered a single aquifer that is cut by Cow Creek.

The piezometer data collected by ITD showed that all of the piezometers had water in them between March and September 2003 (see Figures 5a – 5j). Groundwater levels, although low, were sustained throughout the summer. It was an unusually hot and dry summer, according to anecdotal evidence, indicating that there is groundwater present to sustain wetlands where Cow Creek intercepts the aquifer. During a September 2003 investigation by Entranco personnel, portions of the stream channel had no flow, and an area under the upstream bridge was dry. However, the lower half of the stream had significant volumes of water, although flow was minimal. The gradient of the stream overall is very low, so the channel consisted mainly of sloughs and pools over its entire length at that time. The bottom of the channel was thickly vegetated with actively growing green plants.

The lowest groundwater levels in the piezometers fell within the clay stratum overlying bedrock. The clay appears to be somewhat less permeable than the loess, so lateral transmission of water within that stratum may not be very efficient. However, there is clearly some vertical transmission of groundwater through the clay into the underlying basalt. The basalt is exposed by the stream's base-flow channel nearly the entire reach of the project area. In most places where the stream channel has exposed bedrock, water is present. Where the base-flow channel has been infilled, for example, directly underneath the upstream bridge, open water was not observed during the driest part of the season. However, groundwater was clearly available to the system during this same period. The presence of small water-filled potholes and sloughs, along with relatively lush vegetation on the channel base, are clear indicators of available groundwater.

Stream Morphology

Entranco characterized the geomorphology of Cow Creek at the mitigation site using maps, aerial photographs, field analysis and anecdotal evidence provided by local residents. A Technical Memorandum is included in this document as Appendix A.

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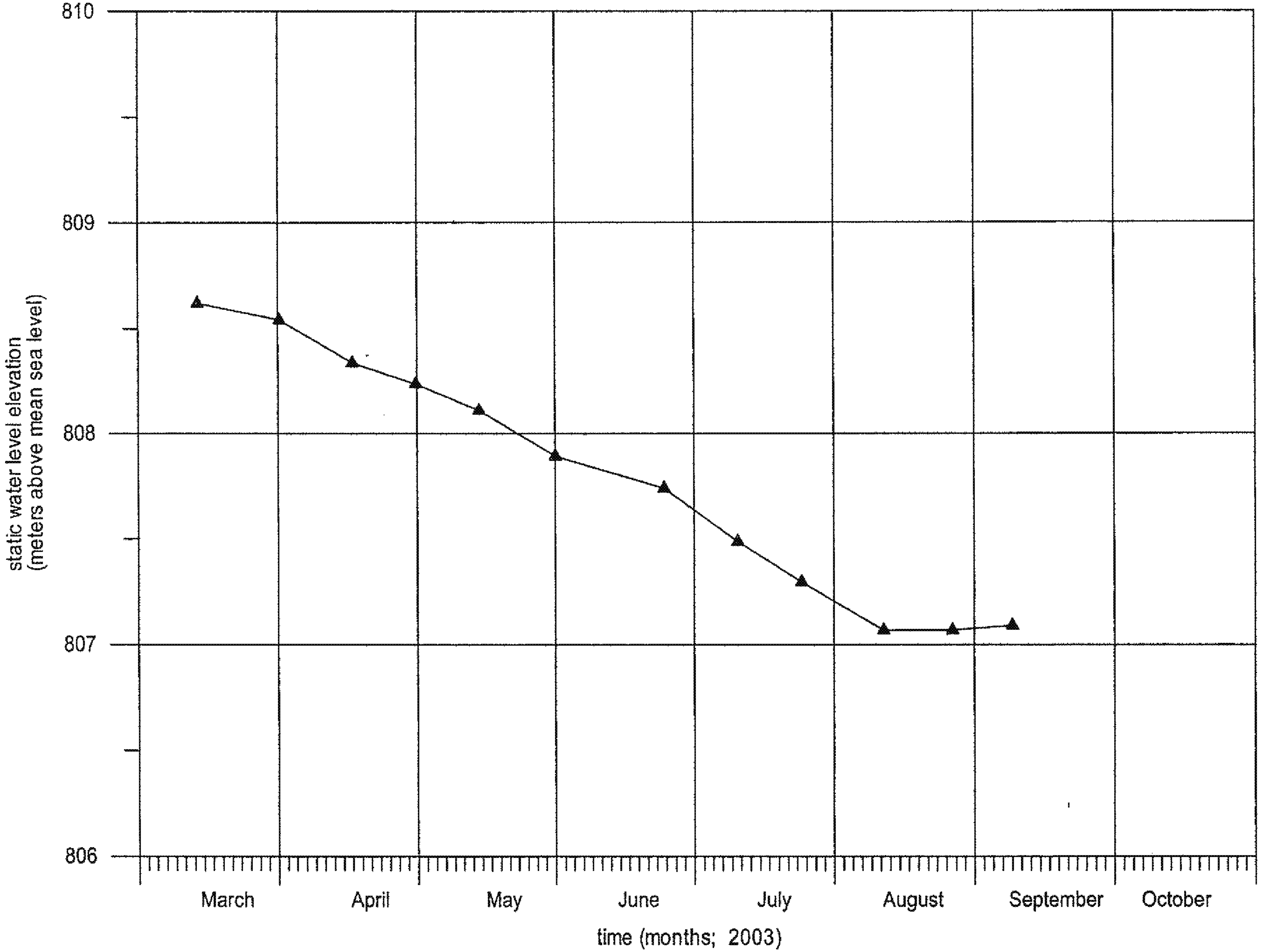

Figure 5a. Graph of time versus static water level in piezometer CCP-1, Cow Creek wetlands mitigation area, Genesee, Idaho.

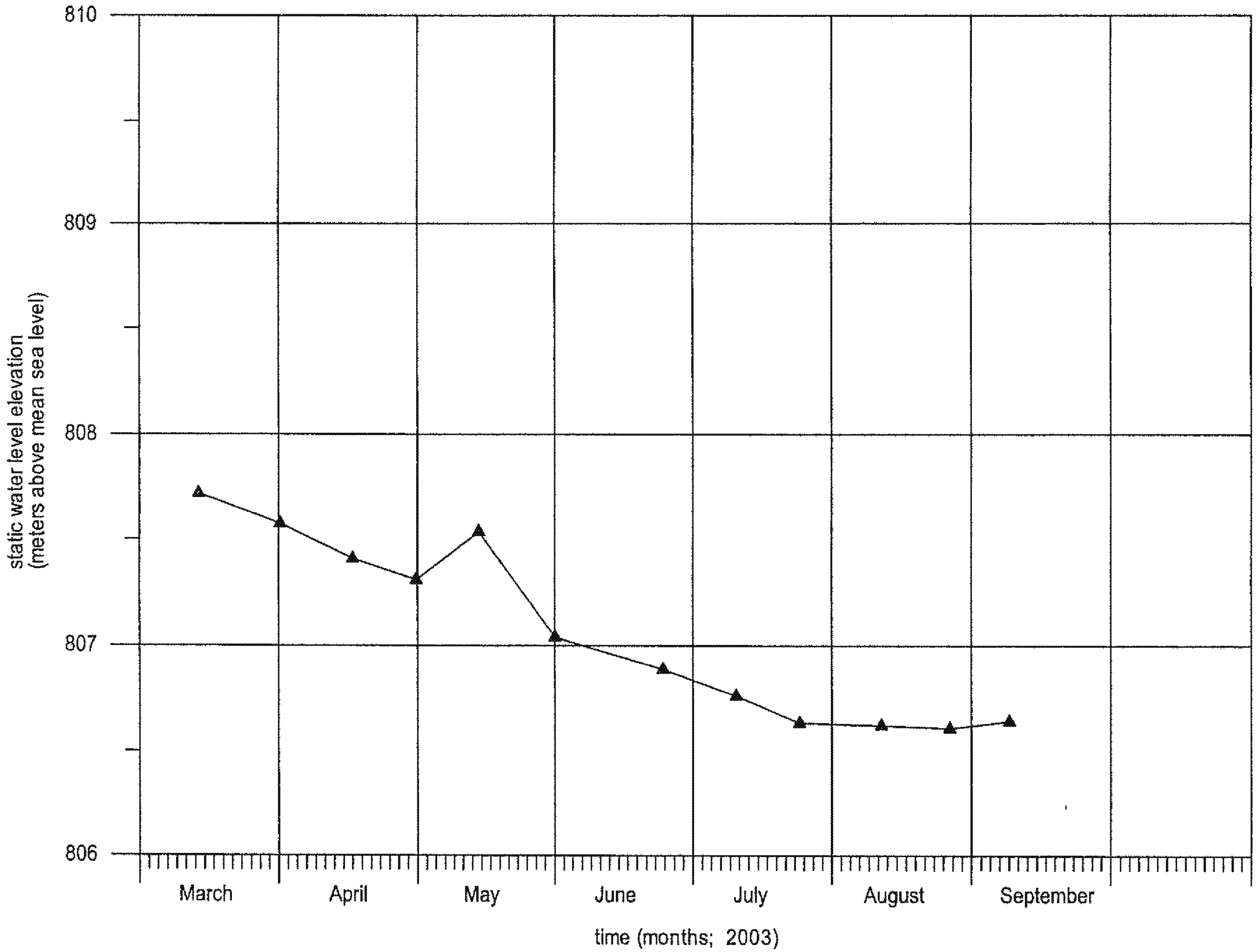

Figure 5b. Graph of time versus static water level in piezometer CCP-2, Cow Creek wetlands mitigation area, Genesee, Idaho.

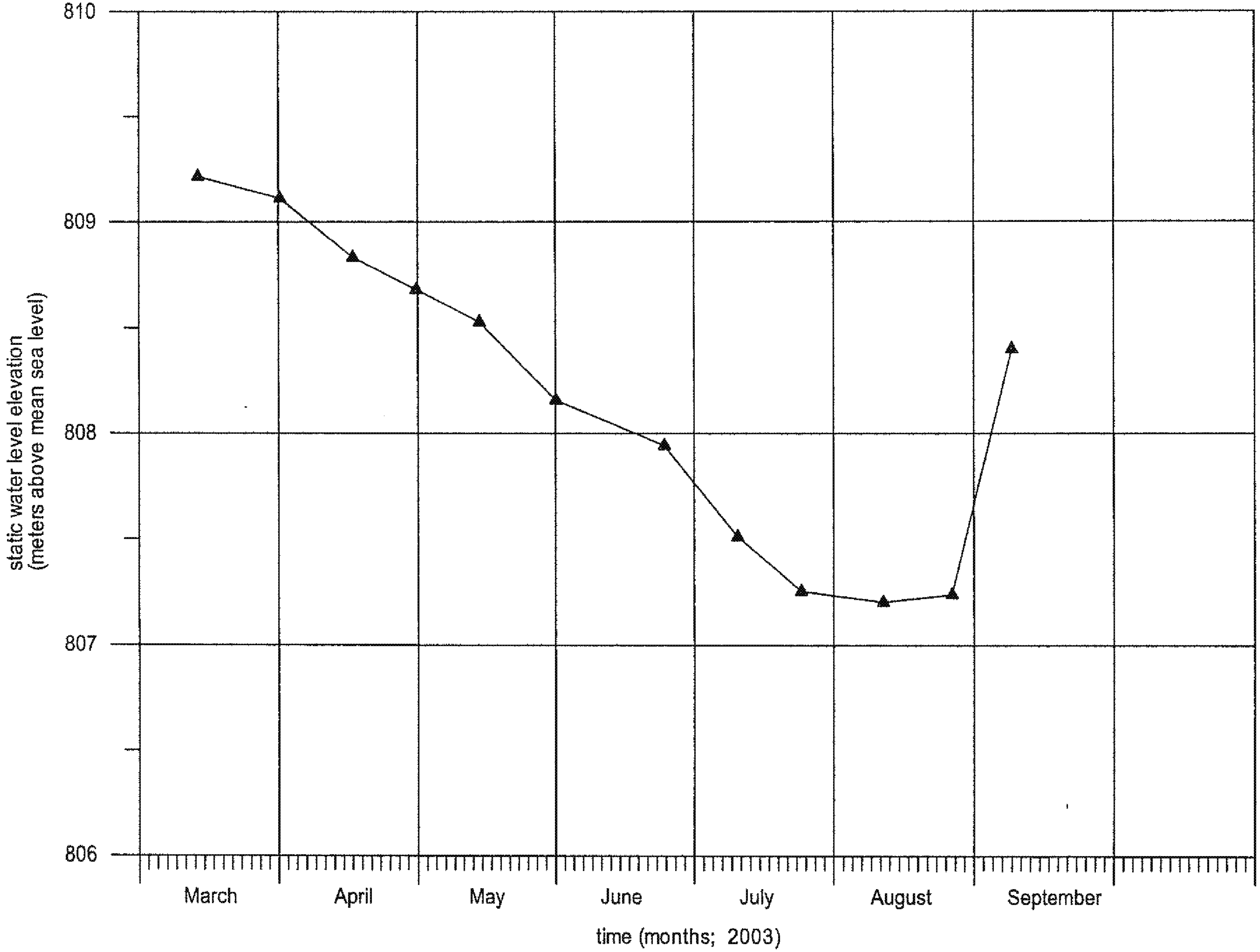

Figure 5c. Graph of time versus static water level in piezometer CCP-3, Cow Creek wetlands mitigation area, Genesee, Idaho.

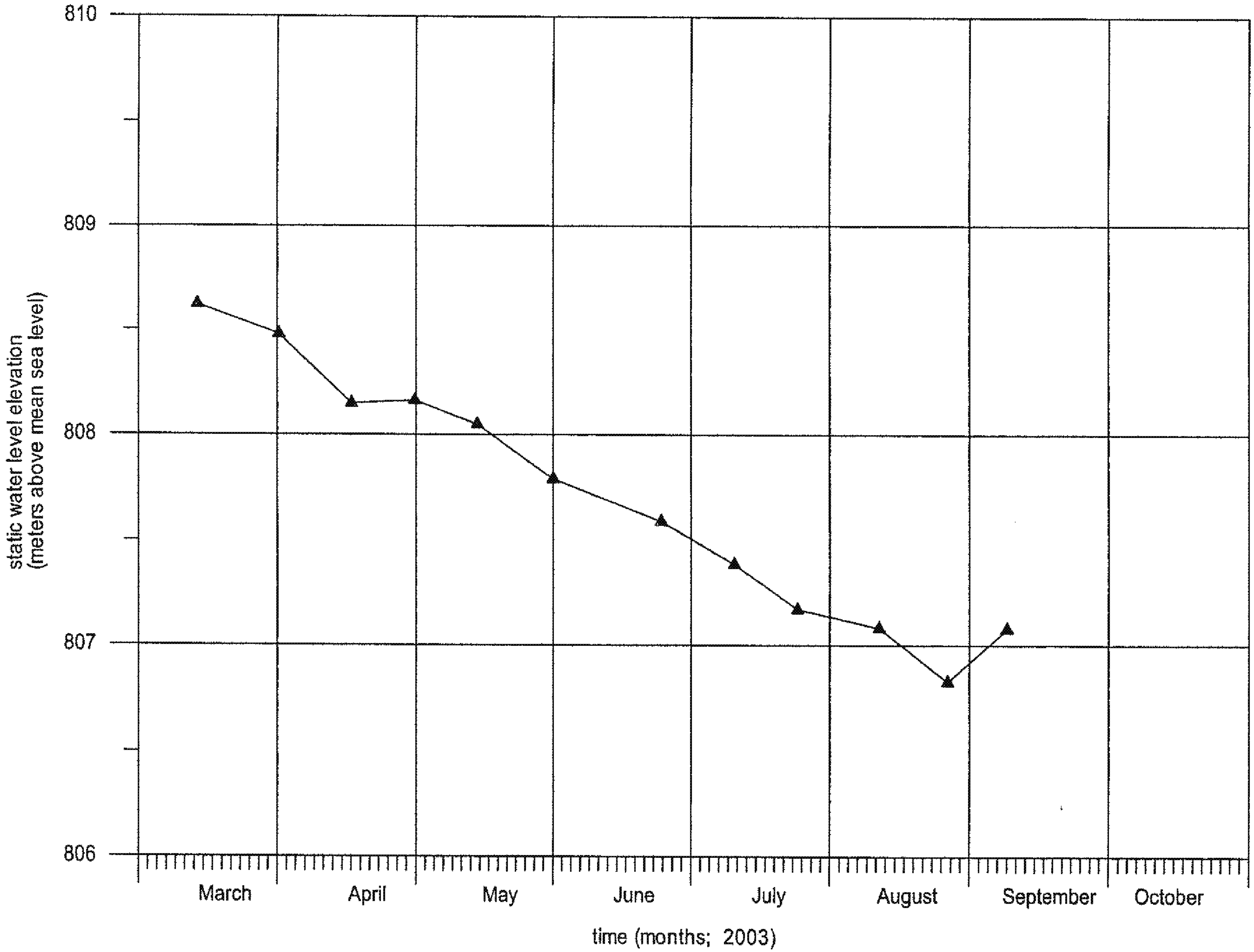

Figure 5d. Graph of time versus static water level in piezometer CCP-4, Cow Creek wetlands mitigation area, Genesee, Idaho.

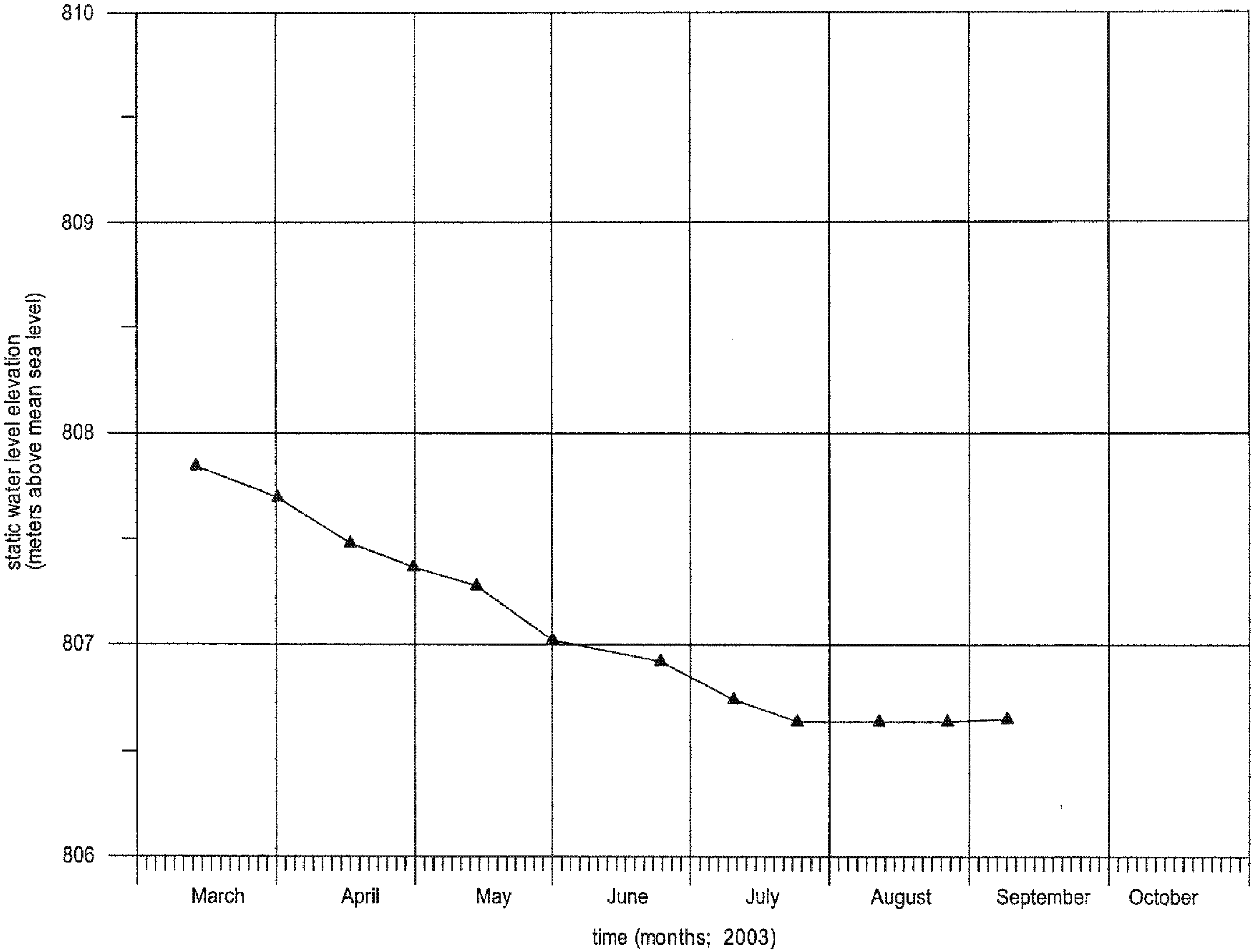

Figure 5e. Graph of time versus static water level in piezometer CCP-5, Cow Creek wetlands mitigation area, Genesee, Idaho.

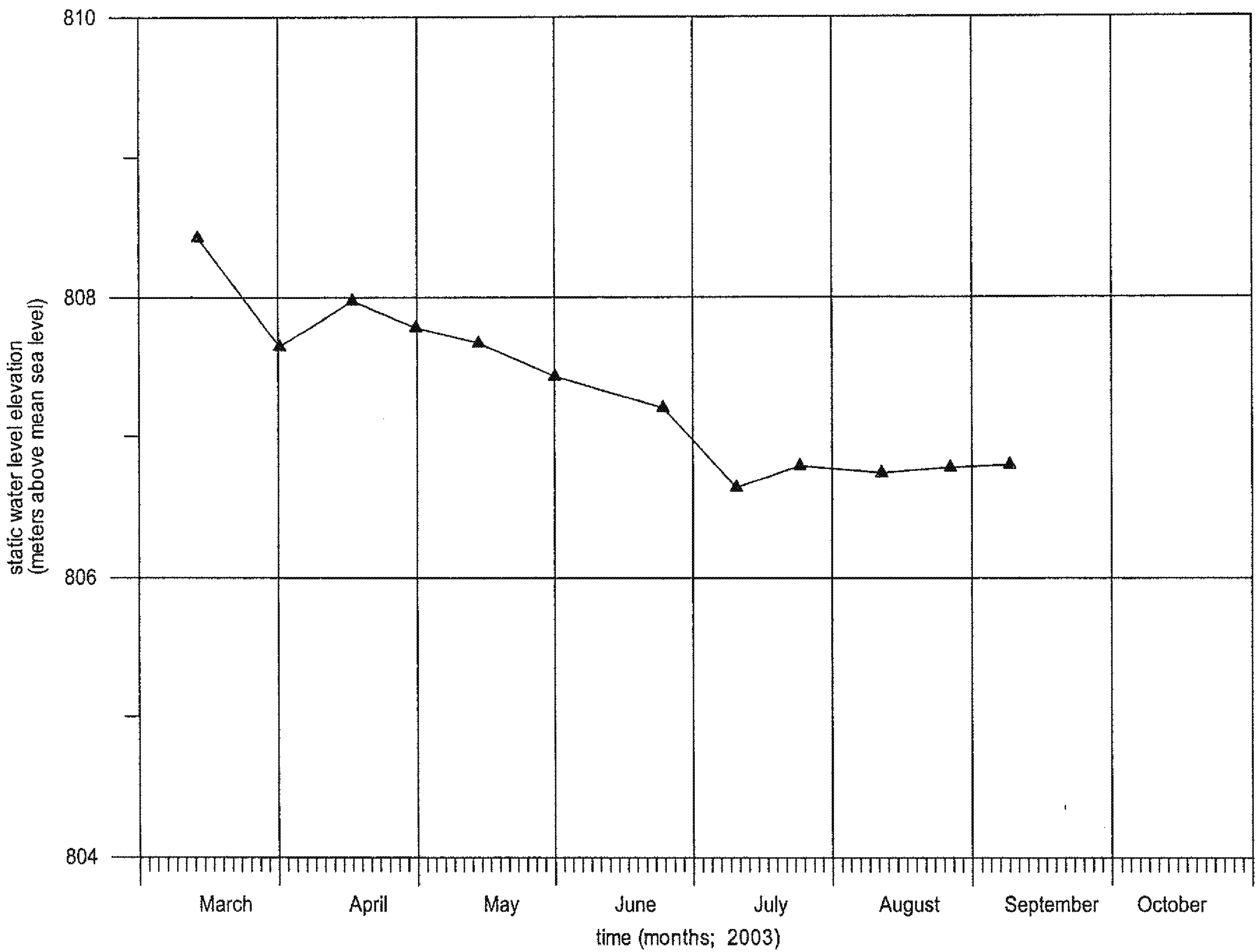

Figure 5f. Graph of time versus static water level in piezometer CCP-6, Cow Creek wetlands mitigation area, Genesee, Idaho.

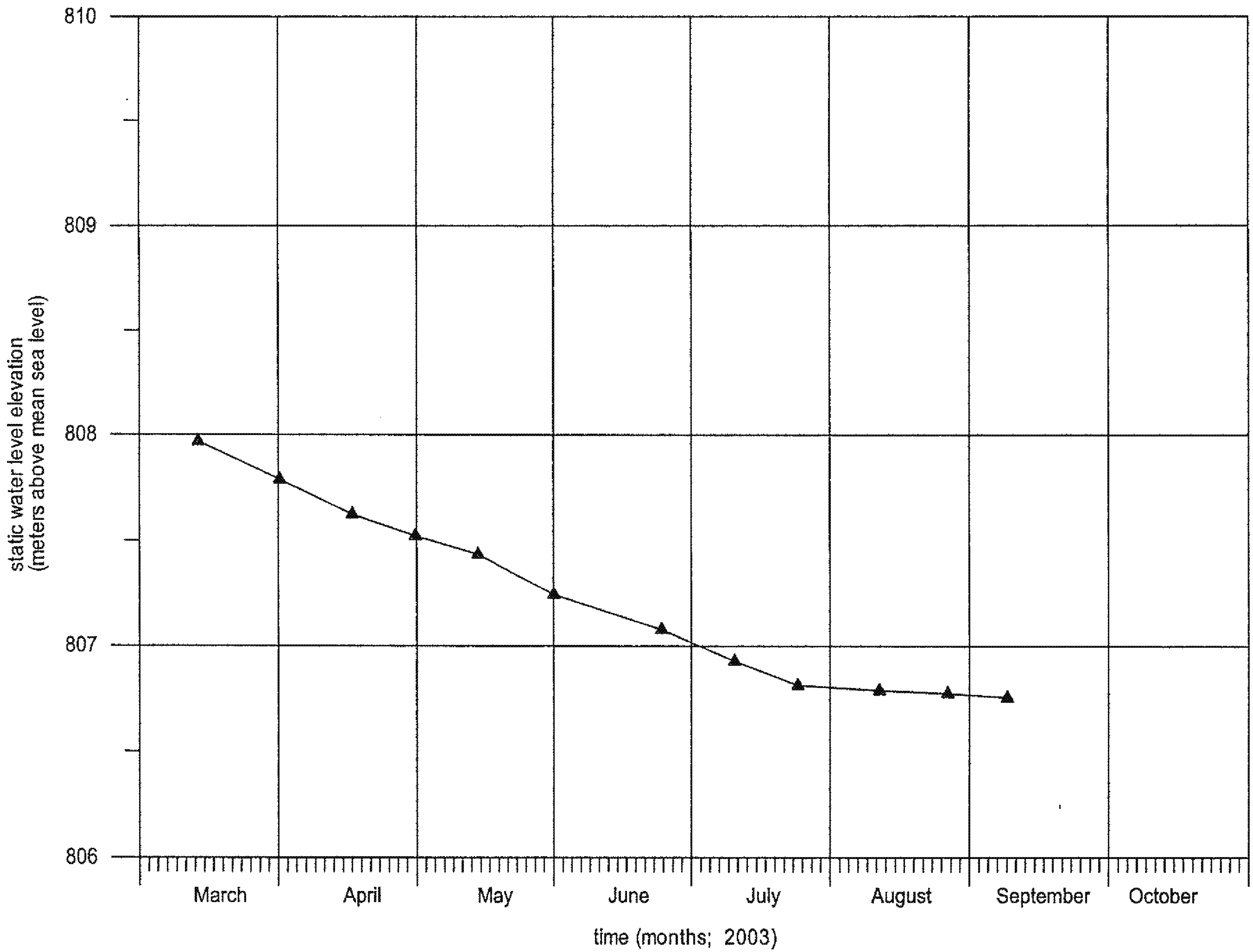

Figure 5g. Graph of time versus static water level in piezometer CCP-7, Cow Creek wetlands mitigation area, Genesee, Idaho.

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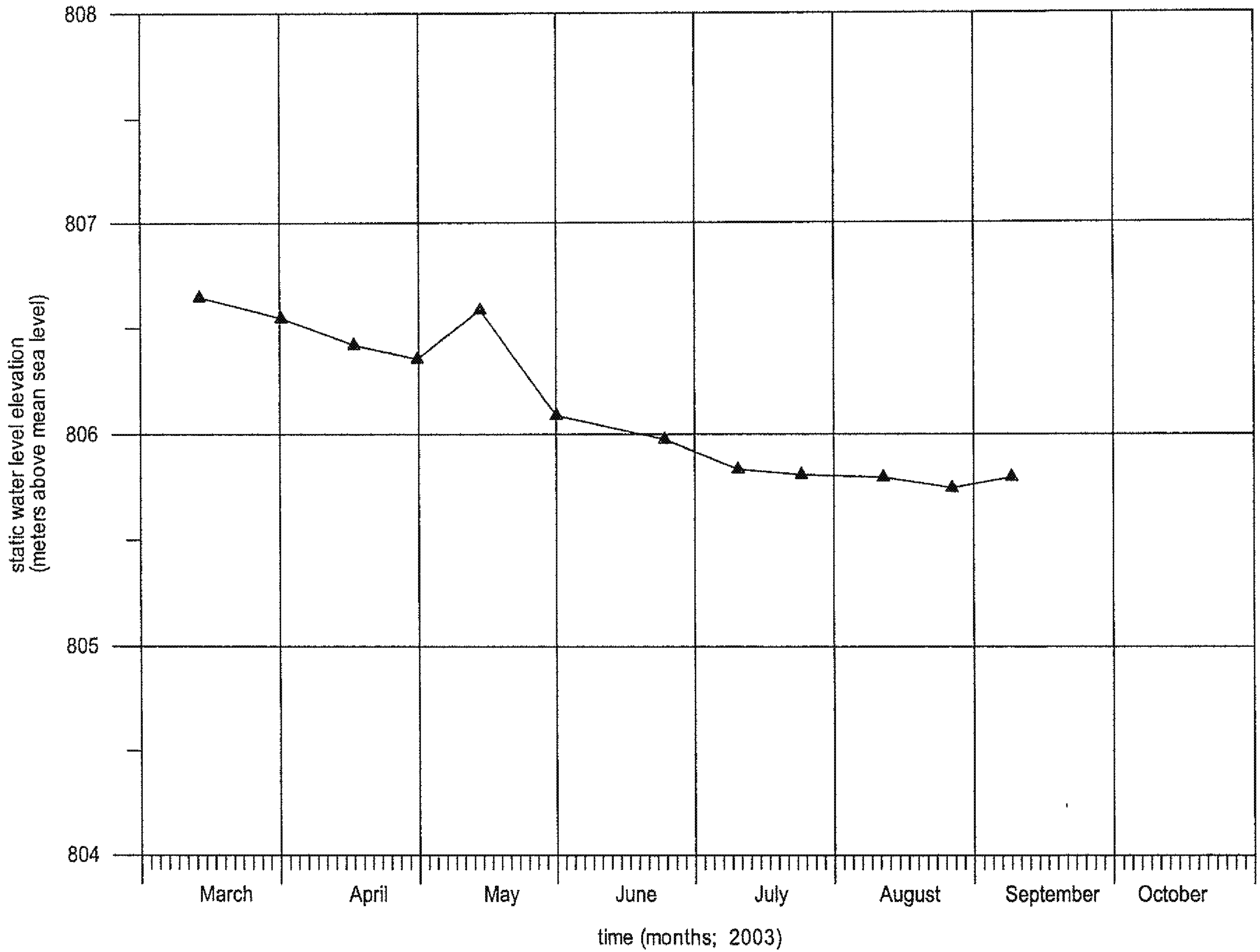

Figure 5h. Graph of time versus static water level in piezometer CCP-8, Cow Creek wetlands mitigation area, Genesee, Idaho.

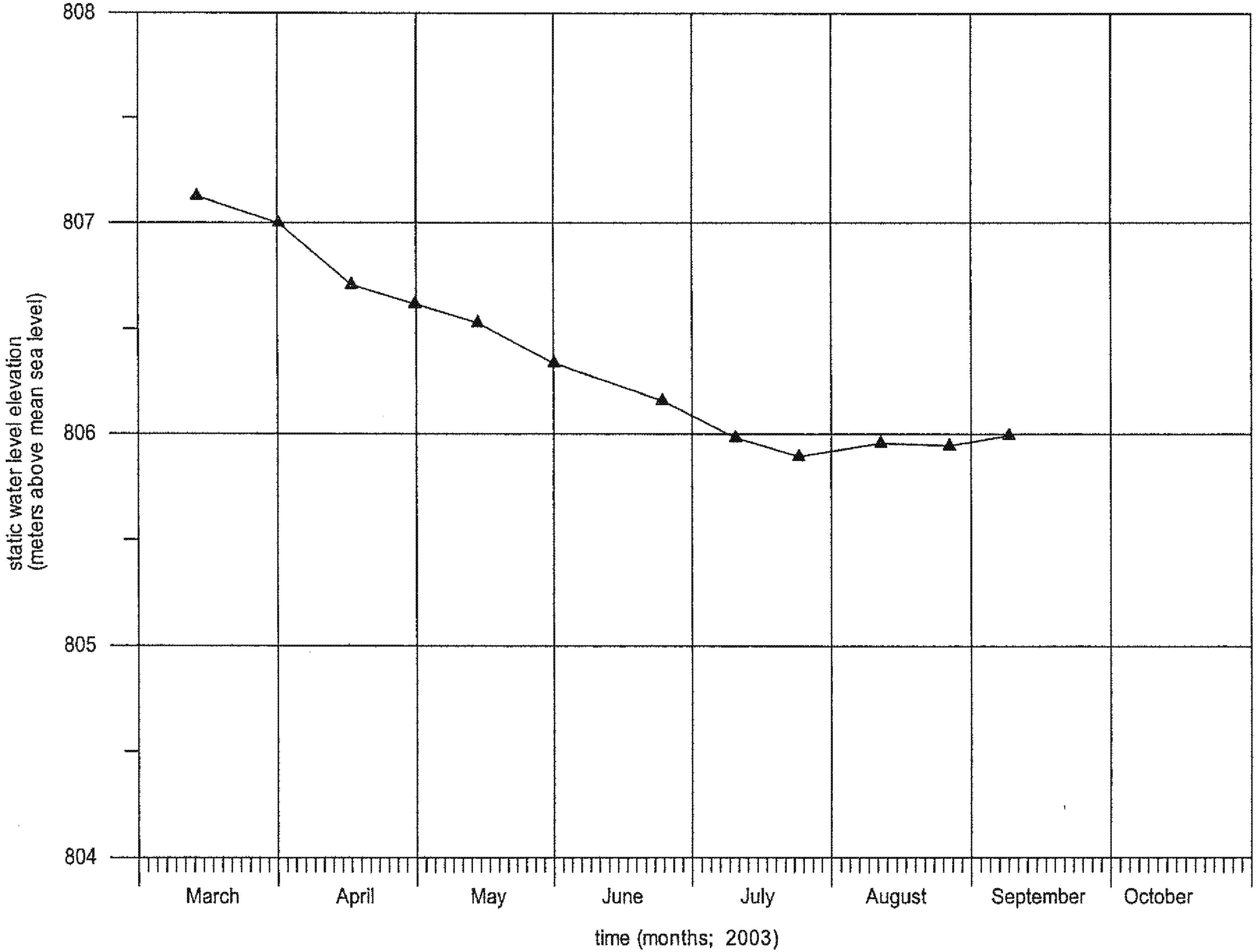

Figure 5i. Graph of time versus static water level in piezometer CCP-9, Cow Creek wetlands mitigation area, Genesee, Idaho.

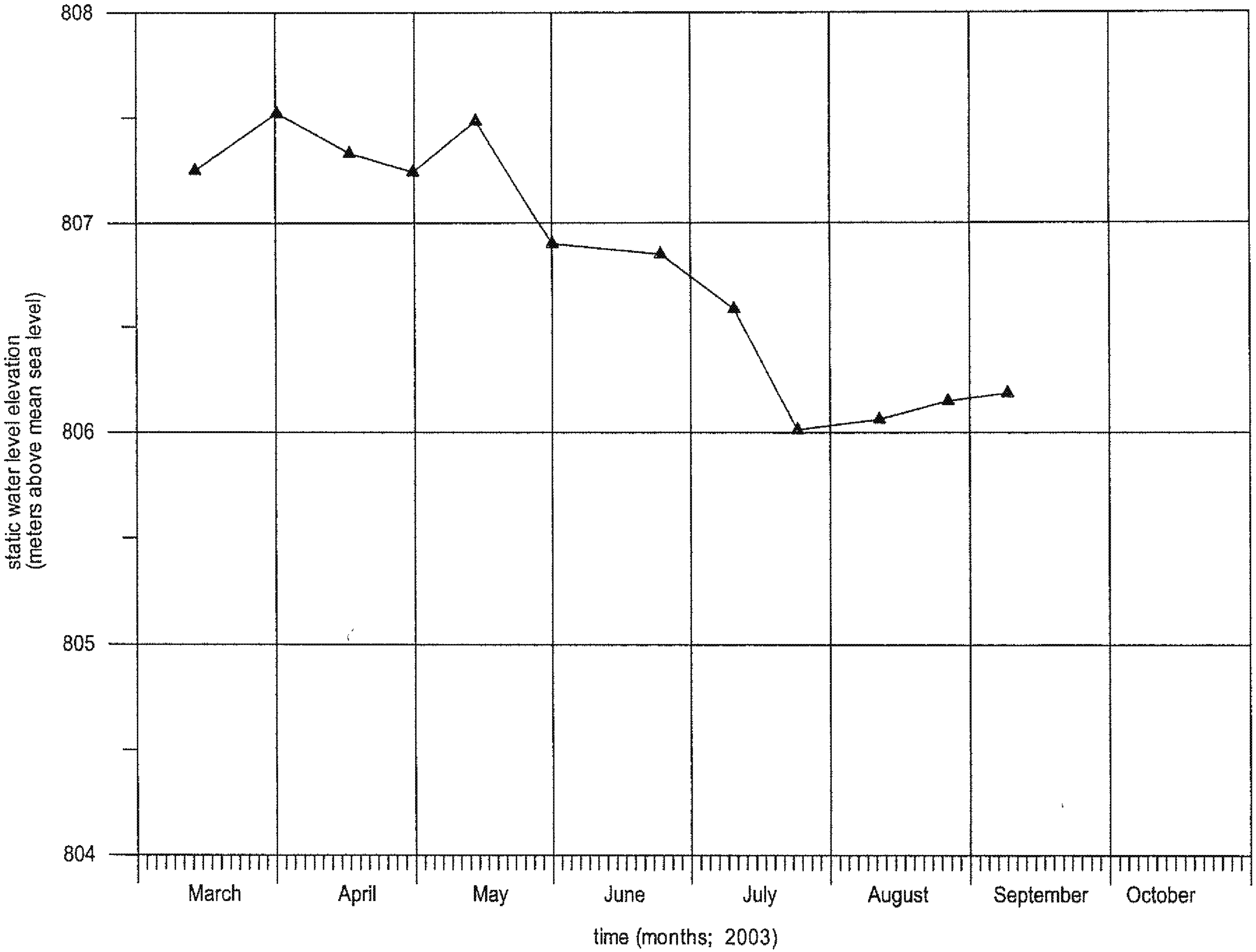

Figure 5j. Graph of time versus static water level in piezometer CCP-10, Cow Creek wetlands mitigation area, Genesee, Idaho.

Cow Creek was reportedly channelized in the late 1940s or early 1950s and subsequently dredged several times. Thus, some aspects of the channel morphology have been obscured or obliterated. Its current configuration does not lend itself to ready classification, but using field measurements collected by Entranco, the stream may be classified as an F6 type stream according to the Rosgen (1996) classification system. This stream type is described as deeply entrenched with a low gradient and a fine-grained (silt and clay) substrate.

Because of the geology and hydrology of this reach of Cow Creek, the channel has developed a bimodal character. Fluvial geomorphologists describe channels in terms of the bankfull characteristics because it is assumed that bankfull discharge is the point at which most work occurs in stream channels. In the western U.S., bankfull is assumed to correlate with a 1.7- to 1.9-year recurrence interval (David Rosgen, personal communication, 2002; 1996). The flow value for a two-year recurrence at Cow Creek is calculated as 10.25 cms (342 cfs). Such flows are, indeed, observed at Cow Creek, but their durations are relatively short, lasting only a day to a few days at most. The result of this situation is that the base flow has created a completely distinct, but considerably smaller channel within the confines of the larger flow channel, the latter of which is defined by the large bankfull events. The smaller channel can be characterized as an E6 channel, which entails a more sinuous channel with a substantial floodplain. However, since the wetlands will be subjected to the larger flows, albeit for very short periods, Cow Creek must be considered in light of the larger flows within the excavated channel. All of the geomorphological and hydraulic investigations were, therefore, conducted under the conditions resulting from the larger, 1.7- to 2-year recurrence events.

Hydraulic Analysis

A set of HEC-RAS hydraulic models of the existing conditions and the proposed channel geometry were developed to determine the response of the discharge, if any, to the creation of the wetlands at Cow Creek. The process and the results are fully described in a Technical Memorandum included in this document as Appendix B. The process involved a number of steps, starting with a representative model of the hydraulics within the channel using the current channel parameters. Using the hydrologic characteristics outlined above, a model was developed and tested at a range of discharges (Appendix B). When possible, the model results were compared to field observations. For example, the modeled bankfull discharge stages were compared to the observed bankfull elevation markers observed in the channel. In this instance, the two elevations were found to be very similar. Some differences occurred, but these can be attributed to parameters such as the roughness coefficient, which may vary more in the stream channel than in the model.

The next step was to model the proposed channel geometry to determine what changes might occur. The primary concerns involved the changes in the bankfull elevation and flow velocity. These characteristics are important to maintain and protect the proposed wetland corridor flanking the channel. Stream velocity changes will occur when the channel is widened to accommodate the wetlands. Widening the channel has the effect of dropping the water surface elevation, which, in turn, raises the velocity of the water as it spreads out. Bankfull elevation will drop, but velocity will slow downstream of the point where the channel widens. This drop in velocity across most of the area will help to protect the wetland areas marginal to the channel.

The proposed wetland slope and vegetation provided the necessary geometric and roughness information required by the model. Test runs led to minor adjustments in the geometry that would ensure that the entire wetland would be inundated at bankfull discharge but protected from high-flow velocities.

The velocities predicted by the HEC-RAS model indicate that neither the forested wetland nor the scrub-shrub/emergent zone will experience excessive erosion from the 2-year flows. Extremely high flow values resulted in some backwater near the downstream bridge, and some overbank flooding. However, these conditions occur at present, so little change in the hydraulic conditions is expected at that point. Flow velocities are predicted to increase at the upstream bridge, so protective measures will be taken to minimize the risk of erosion.

Wetland Impacts

US 95 Corridor

Wetland impacts were calculated within the cut and fill limits of the project design. Twenty-six wetlands were delineated along the Alternative 6 corridor. Eight are non-jurisdictional (see figure 2). A total of 15 wetlands will be affected by the project. Four non-jurisdictional wetlands will be affected.

Approximately 3.5 acres of wetlands will be filled during the construction of Alternative 6. The impacts to the wetlands are largely unavoidable. Alternative 6 closely follows the existing US 95 and the wetlands are along the existing roadway. Any expansion of the road will require filling of the wetlands. It may be possible to minimize these impacts during final roadway design by using retaining walls or shifting the alignment slightly.

Only 3.2 acres of these wetlands are subject to Corps jurisdiction and require mitigation under the authority of the Clean Water Act. Mitigation of wetland impacts will usually require an area that is greater than 1:1 to ensure that wetlands are replaced in both area and function. Current scientific consensus indicates that there is a significant loss of wetland functions over the time it takes for mitigation wetlands to become fully functioning. Mitigation ratios greater than 1:1 are used to compensate for the temporal loss of wetland functions. Also, wetland mitigation success rates have been shown to be less than 50 percent. This means many projects have not met the goal of no net loss or wetland area or functions. Typically, emergent wetlands have a higher degree of success; vegetation becomes established within 1 to 2 years, but the wetlands have lower functional values. Scrub/shrub wetlands typically have lower success rates, take 3 to 5 years to become established, and have higher functions and values. Forested wetlands have low success rates, slow establishment times, and the highest functional values.

The compensation ratio of jurisdictional wetland replacement approved by the Corps for this project will be at least 1 for 1 for palustrine emergent Category IV wetlands, at least 2 for 1 for palustrine scrub-shrub Category III wetlands, and at least 5 for 1 for palustrine forested Category III wetlands. Federal Highway Administration (FHWA) policy requires mitigation for all wetland impacts resulting from FHWA projects. All impacts to wetlands from this project will be mitigated. Non-jurisdictional wetlands will be replaced at a ratio of at least 1 to 1.

Twenty-one wetlands were delineated along Alternative 10A. Three of these were non-jurisdictional. A total of 18 wetlands will be affected by the project. Two non-jurisdictional wetlands will be affected.

Approximately 5 acres of wetlands will be filled to construct Alternative 10A. Alternative 10A is aligned such that it crosses several drainages flowing west off Paradise Ridge. The impacts to the wetlands along these drainages are unavoidable. It may be possible to minimize these impacts during final roadway design by using retaining walls or shifting the alignment slightly.

Approximately 4.9 acres of the wetland impacts along Alternative 10A are subject to Corps jurisdiction and require mitigation under the authority of the Clean Water Act. The ratio of wetland replacement is required to be at least 1:1 for palustrine emergent Category III and IV wetlands, and at least 5:1 for the palustrine forested Category II wetland.

In addition, impacts for two adjacent but separate FHWA projects will be mitigated as part of this project. The South Fork Palouse River Bridge and South Fork Palouse River Bridge to Sweet Avenue projects, located south of Moscow, Idaho, will affect four wetlands. Two wetlands are on the east side of US 95 and two are on the west side. Impacts to Wetland 1 (the north west wetland) will total 0.02 acre. A total of 0.26 acre of Wetland 2 (the southwest wetland) will be filled. The area of impact to Wetland 3 (the southeast wetland) will be 0.14 acre. The impact to Wetland 4 (the northeast wetland) will include 0.05 acre of fill. Wetland impacts total approximately 0.5 acre (Figure 6). These wetlands are not under Corps jurisdiction (N. Braspennickx, personal communication). However, under FHWA policy, all wetland impacts require mitigation. For more information on the South Fork Palouse River Bridge and South Fork Palouse River Bridge to Sweet Avenue projects see Waters of the United States Identification Report (Entranco 2000b).

Cow Creek Wetlands on the Mitigation Site

The Corps serves as the regulatory agent for this project and provided an initial jurisdictional determination. The entire stream system is incised up to 15 feet into the surrounding land, so the wetlands are confined to the floodplain along the bottom of the incised channel and, in some cases, a short distance up the embankment containing the stream.

A wetland delineation (Figure 7), conducted on March 20 and 21, 2003, consisted of marking the sides of the stream channel and the associated width of wetland on either side of the channel. Four-foot laths were used to mark the wetlands and stream channels. The laths were painted with fluorescent paint, marked with a letter designation as to their position relative to channel or wetland, and flagged. There are 2.02 acres of existing wetlands.

The data currently being collected by ITD indicate that groundwater will play a significant part in this system. The water table around the stream is closely aligned with the stream surface elevation, according to current data. The wetland mitigation and stream enhancement will be achieved by grading back the steep loess side slopes of Cow Creek. Regrading the topography will allow seasonal overflows of Cow Creek to reach the created wetlands, increase the effective floodplain adjacent to the stream, and intercept groundwater supplying the wetland hydrology. To avoid wetland impacts, grading for the wetland areas will begin at the outer edge of the existing wetlands.

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Wetland Functions and Values Assessment

Wetland functions are defined as the chemical, physical, and biological processes that contribute to the self-maintenance of wetland ecosystems. Such functions include flood and stormwater control, erosion and shoreline protection, and wildlife habitat. The significance placed on those functions is how important those functions are in a given ecosystem or watershed. Values are determined by human ranking and not wetland attributes.

Wetland functions and values were assessed using the Montana Department of Transportation's *Montana Wetland Assessment Method* (Western EcoTech 1999). Wetlands were not assessed individually but rather, were grouped by type (Cowardin et al. 1979) and watershed. Wetlands were organized into three Cowardin wetland types: palustrine emergent or open water (PEM or POW), palustrine scrub-shrub (PSS), and palustrine forested (PFO). Four watersheds intersect the project corridor. From south to north, the watersheds are Hatwai Creek, Cow Creek, Thorn Creek, and South Fork Palouse River.

A review of existing data, such as U.S. Geological Survey (USGS) maps and stream and fisheries surveys, and site visits were conducted to complete the assessment. Individual functions and values were given a numerical ranking based on certain wetland attributes, which indicate the relative quality of specific wetland functions. These numbers were then used to determine if the function was performing at a high (H), moderate (M), or low (L) level within the wetland. The numerical scores were totaled for each wetland group and converted to a percentage of the total points available. This percentage, along with other criteria specified by the assessment method, is used to rank the wetland groups into one of four categories. Category I is the highest-quality, rare or uncommon wetland. Category II is a high-quality but more common wetland than Category I. Category III is a more common, less diverse, smaller, and often isolated wetland. Category IV is the small, isolated wetland lacking vegetative diversity.

Alternative 6

The PEM wetlands along the existing US 95 were assessed as Category IV wetlands due to their small size and domination by invasive grass. The PSS and PFO wetlands were assessed as Category III wetlands as a result of greater plant diversity. The Category IV wetlands along creeks and drainages were given high ratings in sediment reduction and shoreline stabilization. The grass and herbs in these wetlands reduced water velocity during high-flow events and prevented stream bank erosion. The vegetation in these wetlands also provided moderate ratings in nutrient and toxicant removal and production export. Most wetlands rated low for habitat support for threatened and endangered species, Idaho Natural Heritage Program species, general wildlife, and general fish and aquatic species. Flood attenuation, uniqueness, and recreational and educational potential were rated low in most of the wetlands. Wetlands with scrub-shrub or forested components rated higher in general wildlife habitat and uniqueness.

Alternative 10A

Along existing US 95, the PEM wetlands were assessed as Category IV wetlands, and the PSS and PFO wetlands were assessed as Category III wetlands. The wetlands parallel to the Paradise Ridge portion of the alternative rated slightly higher than the wetlands along existing US 95 due to higher plant species diversity and greater connectivity to surrounding habitat. The PEM wetlands along Paradise Ridge were assessed as Category III wetlands. The PFO wetland was found to be a Category II. The Category IV wetlands along creeks and drainages were given high ratings in sediment reduction and shoreline stabilization. The grass and herbs in these wetlands reduced water velocity during high-flow events and prevented stream bank erosion. The vegetation in these wetlands also provided moderate ratings in nutrient and toxicant removal and production export. Most of the wetlands rated low in threatened and endangered species habitat, Idaho Natural Heritage Program species habitat, general wildlife habitat, general fish and aquatic habitat, flood attenuation, uniqueness, and recreational and educational potential. Wetlands with scrub-shrub or forested components rated higher in general wildlife habitat and uniqueness.

Mitigation

Avoidance and Minimization

Additional measures to avoid and minimize wetland impacts will be considered during final roadway design and may include use of retaining walls or shifting the alignment. Indirect impacts from construction activities will be minimized through preventative measures.

Prior to any ground-disturbing activities, applicable erosion control devices will be put in place. These may include clearing and grading limits, silt fencing, means of stabilizing disturbed soils, sediment trapping devices, runoff collection and treatment, and stone filter dams placed in strategic locations to ensure that any sediment that does reach the waterway is trapped and not washed downstream. Existing ponds along the west drainage of Hatwai Creek will function as sedimentation and erosion control ponds during and after construction. New culverts will include headwall and outlet riprap to reduce erosion potential. An existing pond at station 1021

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will be used for sedimentation during and after construction. These devices shall be monitored and repaired as needed during construction. Additional devices will be installed as directed by the project engineer. Vegetation cleared during construction will be replanted to prevent continued sediment runoff.

Also, a Storm Water Pollution Prevention Plan (SWPPP) would be prepared jointly by ITD and the Contractor and implemented prior to construction. The SWPPP would define the limits of clearing and grading; show the location of silt fencing; establish an excavation window, as necessary; outline methods to stabilize disturbed soils; construct sediment trapping devices; collect and treat runoff; and implement other best management practices (BMPs) necessary to meet state water quality standards. The SWPPP would also include an emergency response plan to address management measures for oil, gasoline, and solvents used in the operation and maintenance of vehicles and machinery.

Replacement

The success of a mitigation project relies on proper planning, good site selection, and an understanding of the environmental variables at the site (Hruby and Brower 1994). The three parameters that define a wetland must be considered in the mitigation plan. The water regime is the most critical aspect of wetland mitigation. The soil must be inundated sufficiently to create the anaerobic conditions that support hydrophytic vegetation. Careful site selection helps ensure a wetland water regime is established on-site.

Another factor to consider during mitigation design is the type of wetland to be created. Native vegetation will be planted to mitigate for the type of wetland affected. Native trees and shrubs will be planted to mitigate for the forested wetlands affected by the project. Native emergents will be planted to mitigate for the emergent wetlands affected by the project.

Long-term protection for the created wetlands is critical to ensure that the functions and benefits derived from the wetlands are preserved. Physical protection is accomplished by establishing a 7.62 m buffer (see figure S-1). These buffers protect the created wetlands from environmental and physical disturbance and provide wildlife habitat for animals, using the wetlands. Plants within the buffer help filter out sediments and pollutants from surface water before it reaches the wetlands. The vegetation also helps regulate the volume of water entering the wetlands by slowing floodwaters. Buffers allow more water to percolate into the soil; this water would otherwise flood the wetland, creating potential erosion and sedimentation, and destroying native wetland vegetation. Buffer effectiveness increases with buffer width. Width is determined based on existing wetland functions, values, and sensitivity to disturbance, buffer characteristics, land use impacts, and desired buffer functions (Castelle et al. 1992).

Created wetlands are protected long term by limiting future development. ITD plans to provide this protection by outright purchase of the mitigation area, including the buffer mentioned above (see Figure S-1). ITD has met with one property owner whose property abuts the Cow Creek Mitigation Site, and the owner has indicated he is willing to sell the area required for this mitigation site. To secure the ROW, plans are being developed and submitted to ITD Headquarters Right-of-Way section for approval. ITD has hired an independent appraiser to appraise the ROW for the mitigation site. Once this report is completed, it will be reviewed by ITD Headquarters Right-of-Way section for accuracy and compliance with state and federal guidelines. After the appraisal report is approved, it will be sent to the District Right-of-Way Supervisor. Next, the report, including a contract and offer, will be mailed to the property owner for review. The package will be sent two to three days prior to setting a meeting. At the meeting, the supervisor will review the report with the property owner and have them sign the official contract or begin additional negotiations for just compensation.

Maintenance and monitoring will ensure that the wetland functions as desired. A contingency plan addressing the shortcomings in the mitigation plan will ensure that the overall goals of the plan are achieved.

The mitigation area for wetland impacts generally is required to be larger than the affected area. It is believed to take 30 to 50 years for a wetland to become a fully functioning part of the ecosystem and the larger area compensates for the wetland functions interrupted by the project (Hruby and Brower 1994).

Alternative 6

Mitigation for jurisdictional PEM wetlands along Alternative 6 requires 1.33 acres of created wetland. Mitigation for jurisdictional PFO wetlands totals 9.25 acres. Mitigation for the remaining non-jurisdictional wetlands is 0.80 acre. A total of 11.4 acres of created wetlands is required to mitigate for Alternative 6 and the South Fork Palouse River Bridge and South Fork Palouse River Bridge to Sweet Avenue projects. The impact areas and mitigation requirements for each wetland are shown in table 1. Impacts and mitigation requirements for each wetland type are shown in table 2.

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Table 1
Wetland Mitigation Requirements for Alternative 6

Wetland (Milepost)	Wetland (Station)	Category[1]	Type[2]	Impact (acre)	Required Ratio[4]	Mitigation (acres)
323.25	STA 1018+25	IV	PEM	0.0015	1:1	0.0015
323.37	STA 1020+20	IV	PEM	0	1:1	0
323.44	STA 1021+20	IV	POWHx	0.1082	1:1	0.1082
325.13	STA 1048+50	IV	PEM	0.1546	1:1	0.1546
325.17	STA 1049+20	IV	PEM	0.0005	1:1	0.0005
327.03	STA 1079+00	IV	PEM	0.5680	1:1	0.5680
328.17	STA 1097+50	Out of ROW	PFO	0	5:1	0
328.24	STA 1098+50	III	PEM/PFO	0.7826	5:1	3.9135
330.70	STA 1138+20	IV	PEM	0.0720	1:1	0.0720
330.85	STA 1140+65 [3]	IV	PEM	0.0404	1:1	0.0404
326.93	STA 1077+50 [3]	Out of ROW	PUBHh	0	1:1	0
330.53	STA 1135+40 [3]	III	PEM/PSS	0.0609	1:1	0.0609
338.97	STA 1149+00	Out of ROW	POW	0	1:1	0
339.59	STA 1159+00 [3]	Out of ROW	POW	0	1:1	0
340.80	STA 1178+60	III	PEM/PFO	0.7614	5:1	3.8070
342.13	STA 1200+00	IV	POWHx	0	1:1	0
342.13	STA 1200+00	IV	POWHx	0	1:1	0
342.13	STA 1200+00	IV	POWHx	0	1:1	0
342.75	STA 2210+00	IV	PEM	0.4253	1:1	0.4253
342.77	STA 2210+30 [3]	IV	PEM	0	1:1	0
342.82	STA 2211+00 [3]	IV	PEM	0	1:1	0
342.96	STA 2213+30	III	PFO	0.1413	5:1	0.7064
343.00	STA 2214+00	III	PSS	0	2:1	0
343.03	STA 2214+50	III	PSS/PFO	0.1639	5:1	0.8195
343.35	STA 2219+60 [3]	IV	PEM	0.1834	1:1	0.1834
343.64	STA 2224+20 [3]	IV	PEM	0.0485	1:1	0.0485
	Wetland 1 [5]	N/A	PEM	0.02	1:1	0.02
	Wetland 2 [5]	N/A	PEM	0.26	1:1	0.26
	Wetland 3 [5]	N/A	PEM	0.14	1:1	0.14
	Wetland 4 [5]	N/A	PEM	0.05	1:1	0.05

1. Per criteria defined in Western EcoTech 1999.
2. Cowardin et al. 1979.
3. Non-jurisdictional wetland.
4. N. Braspennickx, 2001
5. Mitigation for South Fork Palouse River Bridge and South Fork Palouse River Bridge to Sweet Avenue projects.

Table 2 Wetland Mitigation Totals for Alternative 6	Impact Area (acres)	Mitigation Area (acres)
US 95: Lewiston to Moscow Project		
Jurisdiction Wetlands		
PFO	1.8492	9.2459
PSS	0.0000	0
PEM	1.3301	1.3301
Non-jurisdictional	0.3332	0.3332
S. Fork Palouse River Bridge/S. Fork Palouse River Bridge to Sweet Ave. projects	**0**	**0**
Non-jurisdictional	0.47	0.47
TOTAL	**3.9825**	**11.3792**

Alternative 10A

Mitigation for jurisdictional PEM wetlands along Alternative 10A totals 3.93 acres. Mitigation for jurisdictional PFO wetlands totals 4.99 acres. Mitigation for the remaining non-jurisdictional wetlands is 0.57 acre. A total of 9.5 acres of wetland is required to mitigate for Alternative 10A and the South Fork Palouse River Bridge and South Fork Palouse River Bridge to Sweet Avenue projects. The impact areas and mitigation requirements for each wetland are shown in table 3. Impacts and mitigation requirements for each wetland type are shown in table 4.

Mitigation Approach

Wetland Habitat

To compensate for unavoidable impacts to wetlands along Alternative 10A, approximately 11.49 acres of new wetlands are proposed in the Cow Creek floodplain upstream of the US 95 crossing. The mitigation area will create wetlands within the historical Cow Creek floodplain, which has been displaced by agriculture, draining, and dredging practices. The mitigation will include specific grading and bioengineering components in the floodplain to minimize erosion during large flood events. The floodplain mitigation will be located within the entire Cow Creek project area (1,140 meters). The design details of the stream channel and floodplain mitigation

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Table 3
Wetland Mitigation Requirements for Alternative 10A

Wetland (Milepost)	Wetland (Station)	Category[1]	Type[2]	Impact (acre)	Required Ratio[4]	Mitigation (acres)
323.25	STA 1018+25	IV	PEM	0.0015	1:1	0.0015
323.37	STA 1020+20	IV	PEM	0	1:1	0.0000
323.44	STA 1021+20	IV	POWHx	0.1082	1:1	0.1082
325.13	STA 1048+50	IV	PEM	0.1546	1:1	0.1546
325.17	STA 1049+20	IV	PEM	0.0005	1:1	0.0005
327.03	STA 1079+00	IV	PEM	0.5680	1:1	0.5680
328.17	STA 1097+50	Out of ROW	PFO	0	5:1	0.0000
328.24	STA 1098+50	III	PEM/PFO	0.7826	5:1	3.9131
330.70	STA 1138+20	IV	PEM	0.0720	1:1	0.0720
330.85	STA 1140+65 [3]	IV	PEM	0.0404	1:1	0.0404
326.93	STA 1077+50 [3]	Out of ROW	PUBHh	0	1:1	0.0000
330.53	STA 1135+40 [3]	III	PEM/PSS	0.0609	1:1	0.0609
339.28	STA 1154+00	III	PEM	0.6712	1:1	0.6712
339.35	STA 1155+25	III	PEM	0.4458	1:1	0.4458
339.68	STA 1160+50	II	PFO	0.2159	1:5	1.0797
340.06	STA 1166+60	III	PEM	0.1505	1:1	0.1505
340.39	STA 1172+00	III	PEM	0.1348	1:1	0.1348
340.44	STA 1172+75	III	PEM	0.2064	1:1	0.2064
341.07 – 341.11	STA 1182+80 to 1183+50	III	PEM	0.7044	1:1	0.7044
341.21 – 341.30	STA 1185+20 to 1186+50	III	PEM	0.4081	1:1	0.4081
341.82 – 341.95	STA 1195+00 to 1197+00	III	PEM	0.3069	1:1	0.3069
	Wetland 1[5]	N/A	PEM	0.02	1:1	0.02
	Wetland 2[5]	N/A	PEM	0.26	1:1	0.26
	Wetland 3[5]	N/A	PEM	0.14	1:1	0.14
	Wetland 4[5]	N/A	PEM	0.05	1:1	0.05

1. Per criteria defined in Western EcoTech 1999.
2. Cowardin et al. 1979.
3. Non-jurisdictional wetland.
4. N. Braspennickx, 2001
5. Mitigation for South Fork Palouse River Bridge and South Fork Palouse River Bridge to Sweet Avenue projects.

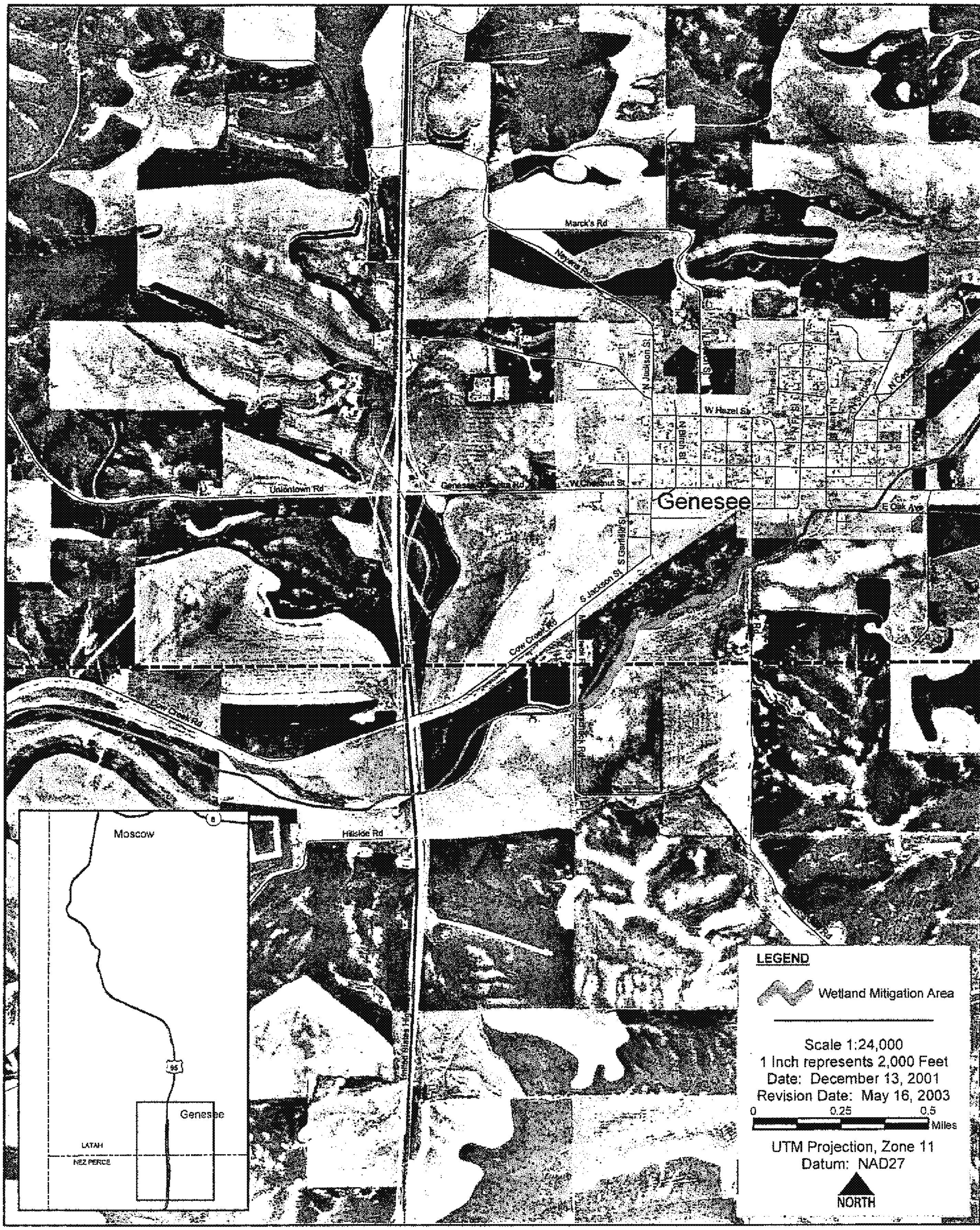
Table 4
Wetland Mitigation Totals for Alternative 10A

	Impact Area (acres)	Mitigation Area (acres)
US 95: Lewiston to Moscow Project		
Jurisdiction Wetlands		
PFO	0.9985	4.9927
PSS	0	0
PEM	3.9329	3.9329
Non-jurisdictional	0.1012	0.1012
S. Fork Palouse River Bridge/S. Fork Palouse River Bridge to Sweet Ave. projects	0	0
Non-jurisdictional	0.47	0.47
TOTAL	**5.5026**	**9.4968**

have been added in this December 2003 update of the Revised Wetland and Stream Mitigation Plan. Permits will be updated with the information. The wetland mitigation plan includes areas of forested, scrub-shrub, and emergent wetland types to mitigate for habitat disturbed by the project and to add habitat diversity to the mitigation site (Figures 8 and 9). Appendix D has current U.S. Army Corps of Engineers guidance on wetland mitigation.

The mitigation plan will enhance 2.02 acres of palustrine emergent (PEM) wetland. The plan would also create of 3.98 acres of palustrine scrub/shrub (PSS) and 7.51 acres of palustrine forested (PFO) wetland a total of 11.49 acres of created wetland. The mitigation requirements for Alternative 10A require 9.50 acres of creation (see table 4): 3.93 acres of PEM, 4.99 acres of PFO, and 0.57 acre for non-jurisdictional wetlands based on impacts to these types of wetland. No PSS wetlands are being impacted; therefore, no PSS creation is required for mitigation.

The Cow Creek site provides an excellent opportunity to enhance the existing PEM wetlands along the stream corridor. Presently, reed canarygrass dominates wetlands along the stream. Mitigation plantings will add diversity and enhance the overall functions and values of the wetlands. Over time, riparian plantings will shade the stream and wetlands and help to reduce the reed canarygrass coverage. A PSS area is proposed adjacent to the enhanced PEM wetlands in the mitigation plan. This structure more closely imitates the natural configuration of a riparian system. The larger woody stems of the shrubs will help mitigate flood damage from Cow Creek, protecting the site from erosion. The species variety will provide better wildlife habitat and shade for the creek. A band of PFO wetland is proposed furthest from the stream adjacent to the PSS area.



This MAP is for general planning purposes only, and is subject to updates and changes. Any user should check with the Idaho Transportation Department prior to use to be sure that the data shown is current. Because of the scale of this map, any user should not rely on it for the exact definition of any boundary or division line shown on said map.

This MAP is based on information from numerous sources and the accuracy of which in not guaranteed by the Idaho Transportation Department. The Idaho Transportation Department is not responsible and shall not be liable to the user for damages of any kind arising from the data or information shown of this map.

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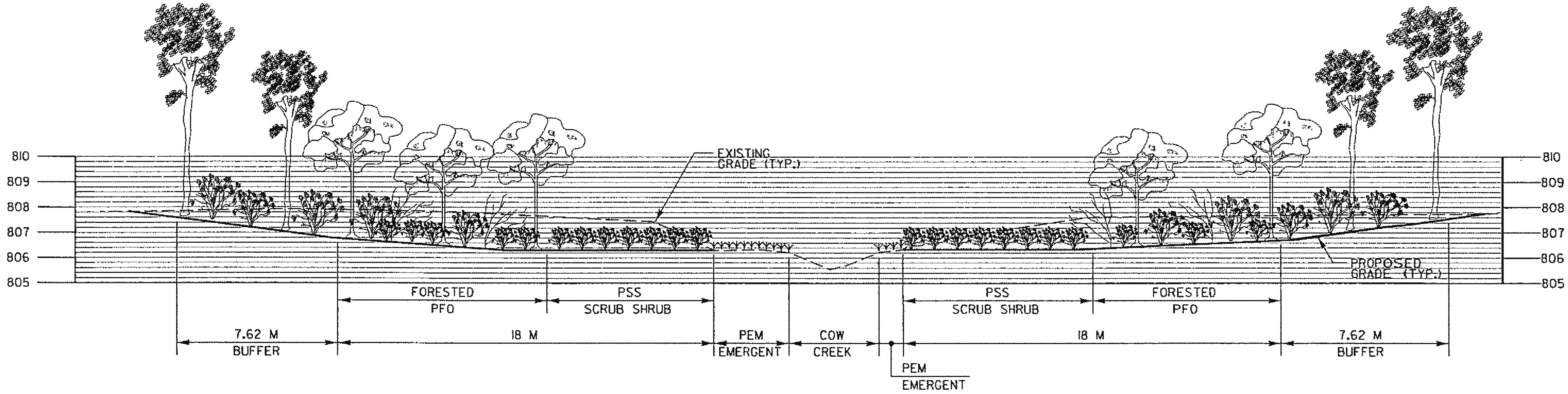
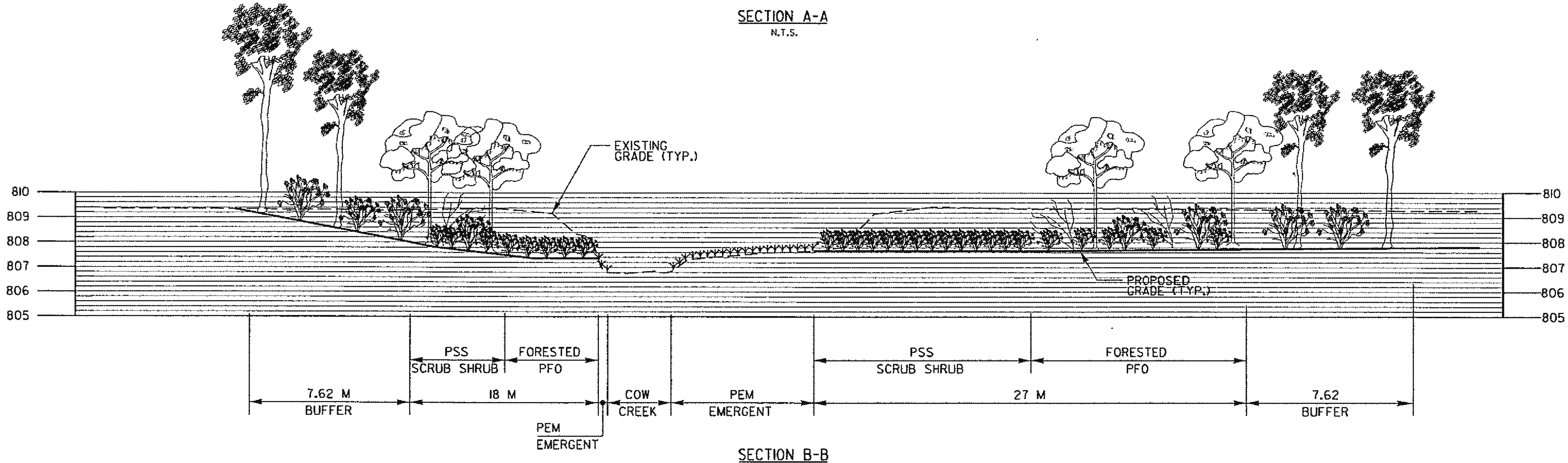
Figure 8
Wetland Mitigation



SECTION A-A
N.T.S.



SECTION B-B
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NO.	DATE	BY	DESCRIPTION	DESIGN CHECKED			NH-4110(133)	US-95 TOP OF LEWISTON HILL TO MOSCOW CROSS SECTIONS	COUNTY LATAH/NEZ PERCE
				DETAILED	CADD FILE NAME				KEY NUMBER 7769
				DRAWING CHECKED	DRAWING DATE:				FIGURE 9

12/19/2003

The wetland mitigation is proposed along Cow Creek east of US 95. This site was selected for its proximity to the affected areas, connectivity to the creek, and high probability of success. The proposed wetland mitigation consists of a linear riparian corridor excavated adjacent to the stream channel (see Figure 8). This design is based on a cohesive approach that will (1) create fewer impacts for landowners, (2) create a continuous corridor that will attract wildlife, and (3) help stabilize the stream. Additional stream stabilization has been proposed to minimize severe erosion and protect the created wetlands (See Appendix A for details).

The wetland mitigation areas will provide general wildlife and aquatic habitat. Specific wildlife enhancement features (e.g., brushpiles) have been proposed. Excavating the existing grade adjacent to the stream will create additional flood storage and attenuation (Figure 10). Groundwater recharge will occur from the increased water storage. Sediment, nutrient, and toxicant removal will increase from retaining the creek water longer in the wetland areas. Trees and shrubs planted along the riparian corridor will shade the creek and reduce water temperature (see Figure 9). The emergent zone proposed for the area adjacent to the creek will remove sediment from runoff entering the creek and improve water quality. Temperature, nutrients, and habitat are listed pollutants for Cow Creek under the 303(d) program (K. Cole, personal communication).

Woody debris will be placed in the wetland to increase cover for wildlife. Native wetland plants with high wildlife value will be planted to provide for wildlife use and shade for the stream. All vegetation planted on the project will be native to the meadow steppe region.

Stream Channel Restoration and Streambank Stabilization

A major concern is the possibility that an extremely high Cow Creek discharge may impact newly planted wetlands. Entranco is proposing that a number of structures be installed at strategic locations to reduce flow velocity on the edges of the channel and maintain the velocity in the area of the existing channel base. The protective structures are based on "natural" channel engineering properties proposed by Rosgen (1996; 2001). The Cow Creek mitigation area will experience generally slower flow velocities and a lower bankfull stage with the new channel geometry. While inundation of the wetlands is an important aspect of the project, maintaining appropriate flow velocities down the center of the channel is equally important.

The design concept for protective structures involves the placement of cross-vanes at points where bank stabilization needs to be maintained or where the main flow of the channel requires concentration. The cross-vanes are proposed to be constructed of boulders. The vanes will extend from the

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bankfull elevation on the stream bank into the flow at angles from 20 to 30 degrees to the flow direction. The vanes will slope into the flow at an angle of more than two degrees but less than seven degrees. A lower angle may be preferable at Cow Creek to reduce the possibility of scour downstream of the structure. The structures are intended to slow the stream velocity close to the bank and redirect the flow toward the center of the channel.

In addition to the vanes, the area under the upstream bridge will be armored, as will the channel banks for a distance of 25 meters downstream of the wingwalls. This precaution is being taken to protect the bridge and channel in the event of extremely high Cow Creek flows (100-year-plus recurrence intervals).

The cross-vanes and vegetation plantings will also stabilize the streambanks. The cross-vanes reduce flow velocities near the streambanks and redirect the flow toward the center of the channel. The scrub-shrub and forest vegetation will increase the roughness of the channel during times of higher flow, which will also encourage flow down the center of the channel. In addition, simply laying back the streambanks to a lower angle will aid in spreading the flow out and reducing near-bank flow velocities.

These measures have been designed as a response to "flashy," high-discharge events that occur for very brief periods during the late winter. These events commonly occur over the course of one to three days and recede nearly as quickly as they arise, which is a typical hydrologic response to rain-on-snow events. Thus, the structures within the proposed channel have been hydraulically evaluated and engineered, given the flow regime observed in Cow Creek during all but a few days of the year. During periods of normal base flow, the existing base-flow channel will continue its development without interference. The base-flow channel is cut into clay that is difficult to erode, and the channel is relatively stable in its current configuration. No structures or additional stabilization is proposed for the base-flow channel.

Reference Wetland

Several wetland and riparian areas were considered as potential reference wetlands (N. Braspennickx, personal communication). Because the Palouse region has been converted from native grassland to farmland and pasture for several generations, it is rare to find areas undisturbed by agriculture. Invasion from crops and other introduced species has influenced sites untouched by plows.

The Rose Creek Preserve was identified as a viable reference wetland. A site visit to the Rose Creek Preserve near Pullman, in southeastern Washington, took place on February 11, 2003. The preserve contains one of the best black hawthorn/cow parsnip riparian areas left in the entire Palouse, a plant association that is appropriate for the mitigation at Cow Creek. At Rose Creek and a few other sites, the relationship between black hawthorn and quaking aspen is particularly complex. As the aspen grows, it shades out the hawthorn, which dies back to rootstocks, only to re-emerge when the short-lived aspen falls victim to heart rot. Following a dormant period, the aspen sprouts again and the cycle repeats.

The Cow Creek site is atypical for the Palouse because it is much flatter than most of its surroundings (including this reference wetland and the area being filled to expand US 95). Although the Rose Creek topography does not directly correspond to that found at Cow Creek, we have been unable to locate a more appropriate site as a reference for the relationship between the plants and hydrology for our site.

A master plant list (table 5) for the mitigation planting was developed by using several published references:

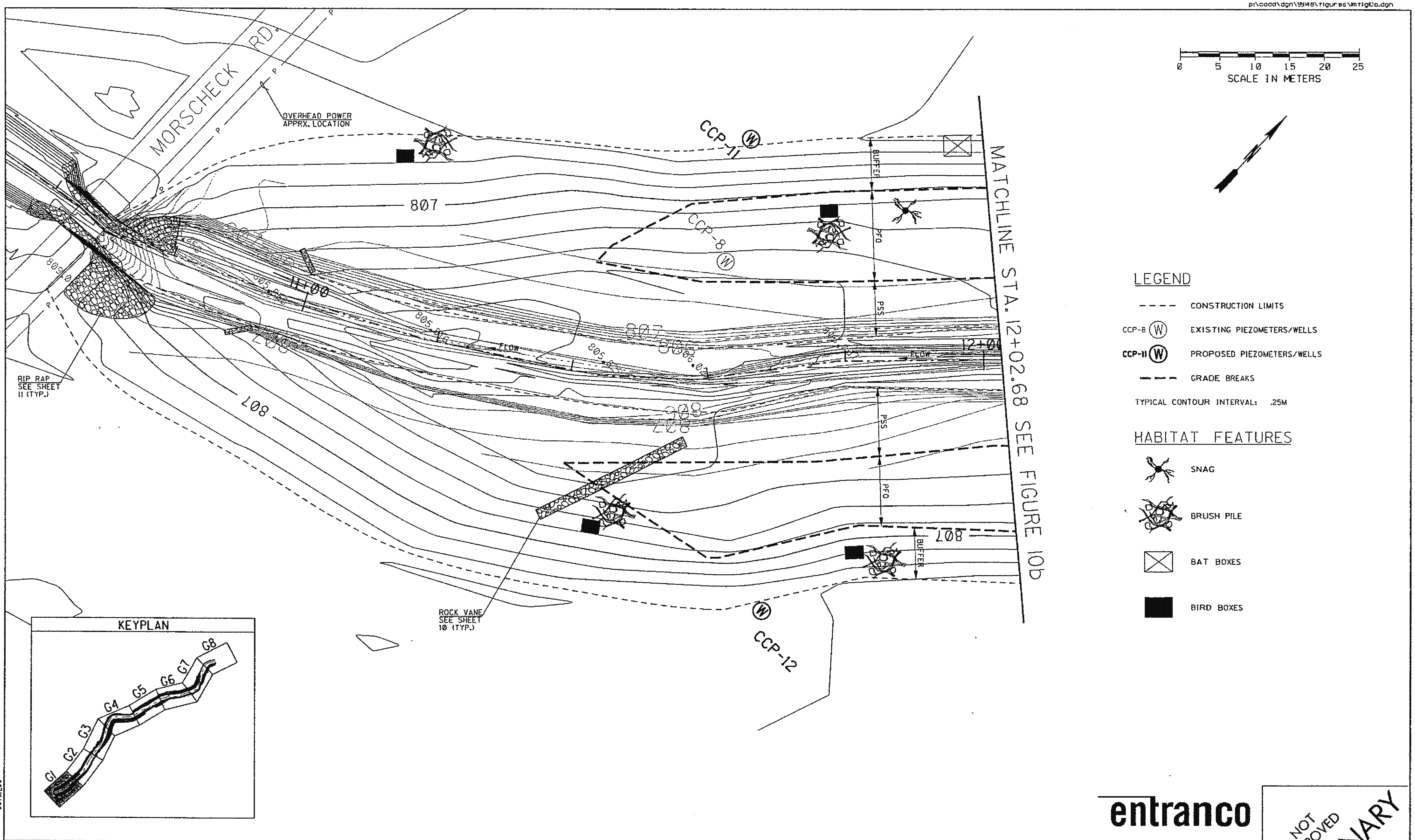
- Wetlands of the Palouse Prairie: Historical extent and plant composition (Servheen et al. 2002)
- Native Plants of the Palouse Prairie (Palouse Prairie Foundation 2003)
- Plants of the Rose Creek Preserve (Washington State University 2003)
- Pacific Northwest Conservation Assessment published by the Conservation Biology Institute 2002

Additional guidance from the Idaho Department of Environmental Quality (IDEQ) was considered in selecting tree species (C. Barrett, personal communication).

Table 5
Plant List for Mitigation Planting

Latin Name	Common Name	WIS1
Upland Buffer Plantings:		
Abies grandis	Grand Fir	FACU-
Amelanchier alnifolia	Saskatoon Serviceberry	FACU
Ceanothus sanguineus	Redstem Ceanothus	NI
Crataegus columbiana	Columbia Hawthorn	NI
Elymus glaucus	Blue Wildrye	FACU
Galium boreale	Northern Bedstraw	FACU
Geranium viscosissimum	Sticky Purple Geranium	FACU+
Lomatium dissectum	Fern-Leaf Biscuitroot	NI
Philadelphus lewisii	Lewis' Mock Orange	NI
Prunus virginiana	Common Chokecherry	FACU
Rhus trilobata	Skunkbush Sumac	FACU
Rosa woodsii	Woods' Rose	FACU
Rubus parviflorus	Western Thimbleberry	FACU+
Symphoricarpos albus	Snowberry	FACU
Forested Wetland (PFO):		
Acer glabrum	Mountain Maple	FAC
Alnus incana	Speckled Alder	FACW
Alnus rubra	Red Alder	FAC
Betula occidentalis	Water Birch	FACW
Circaea alpina	Small Enchanter's Nightshade	FAC+
Crataegus douglasii	Black Hawthorn	FAC
Populus tremuloides	Quaking Aspen	FAC+
Tiarella unifoliata	Western Foamflower	FAC-
Scrub-Shrub Wetland (PSS):		
Cornus sericea	Red-Osier Dogwood	FAC-
Lupinus polyphyllus	Big-Leaf Lupine	FAC+
Potentilla gracilis	Five-Finger Cinquefoil	FAC
Ribes aureum	Golden Current	FAC/FACW
Rosa nutkana	Nootka Rose	FAC
Sambucus cerulea	Blue Elderberry	FAC-
Spiraea betulifolia	Shiny-Leaf Spirea	FAC
Emergent Wetland (PEM):		
Aster eatonii	Eaton's Aster	FAC+
Carex nebraskensis	Nebraska Sedge	OBL
Carex utriculata	Beaked Sedge	OBL
Eleocharis palustris	Spikerush	OBL
Elymus cinereus	Great Basin Wild Rye	NI
Iris missouriensis	Western Iris	FACW+
Juncus balticus	Baltic Rush	OBL
Mimulus guttatus	Seep Monkeyflower	OBL

Source: Franklin and Dyrness 1988 Crataegus douglasii associations; Rose Creek Preserve reference wetland; and J. Chris Hoag, Wetland Plant Ecologist, Aberdeen PMC, ID
1. WIS=Wetland Indicator Status. Per Reed 1993



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				DETAILED	CADD FILE NAME				KEY NUMBER 7769
				DRAWING CHECKED	DRAWING DATE:				FIGURE 10a

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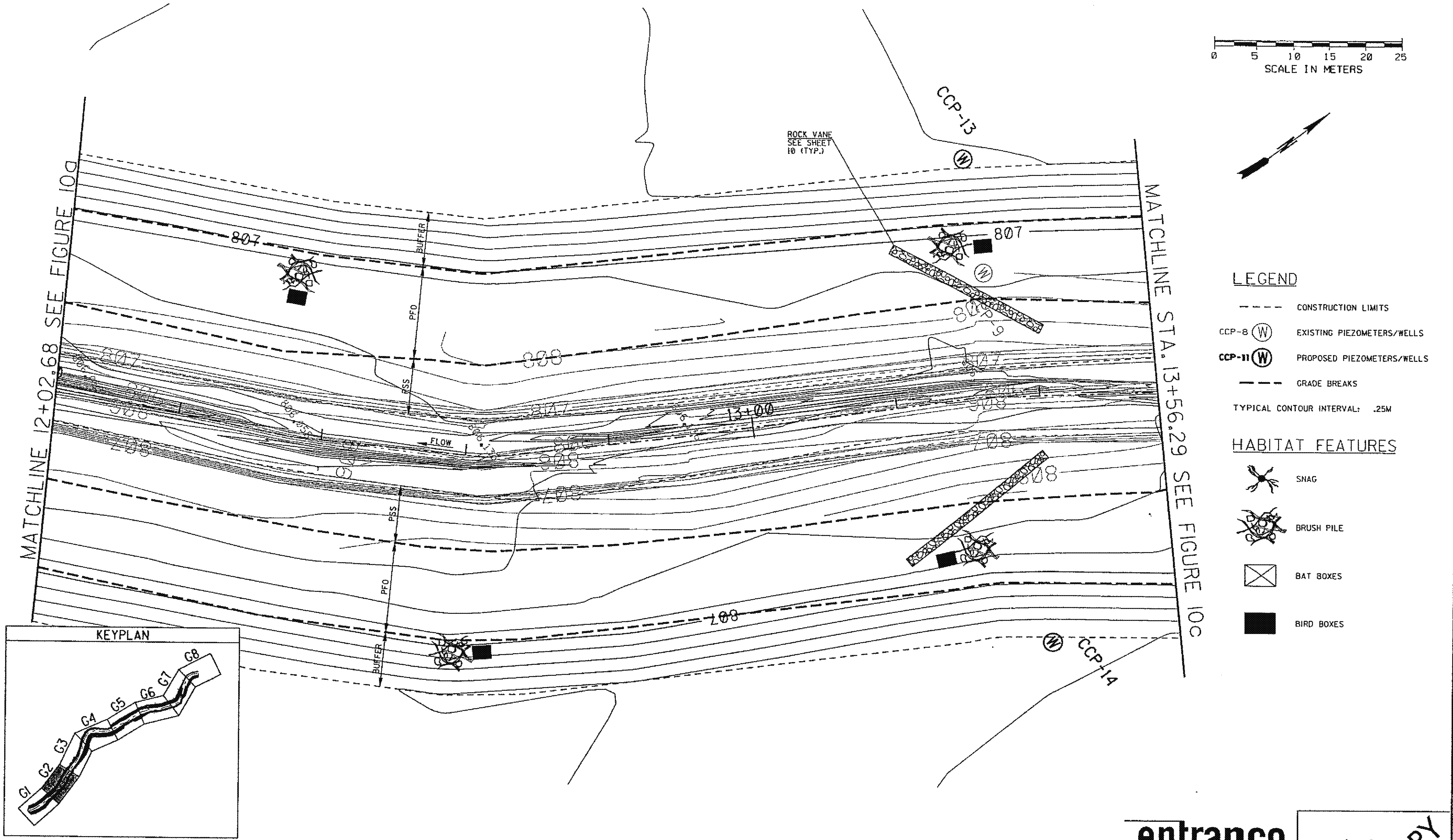

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FEDERAL AID PROJECT NO.
NH-4110(133)

WETLAND MITIGATION
US-95
TOP OF LEWISTON HILL TO MOSCOW
G2 - GRADING PLAN

metric
COUNTY LATAH/NEZ PERCE
KEY NUMBER 7769
FIGURE 10b

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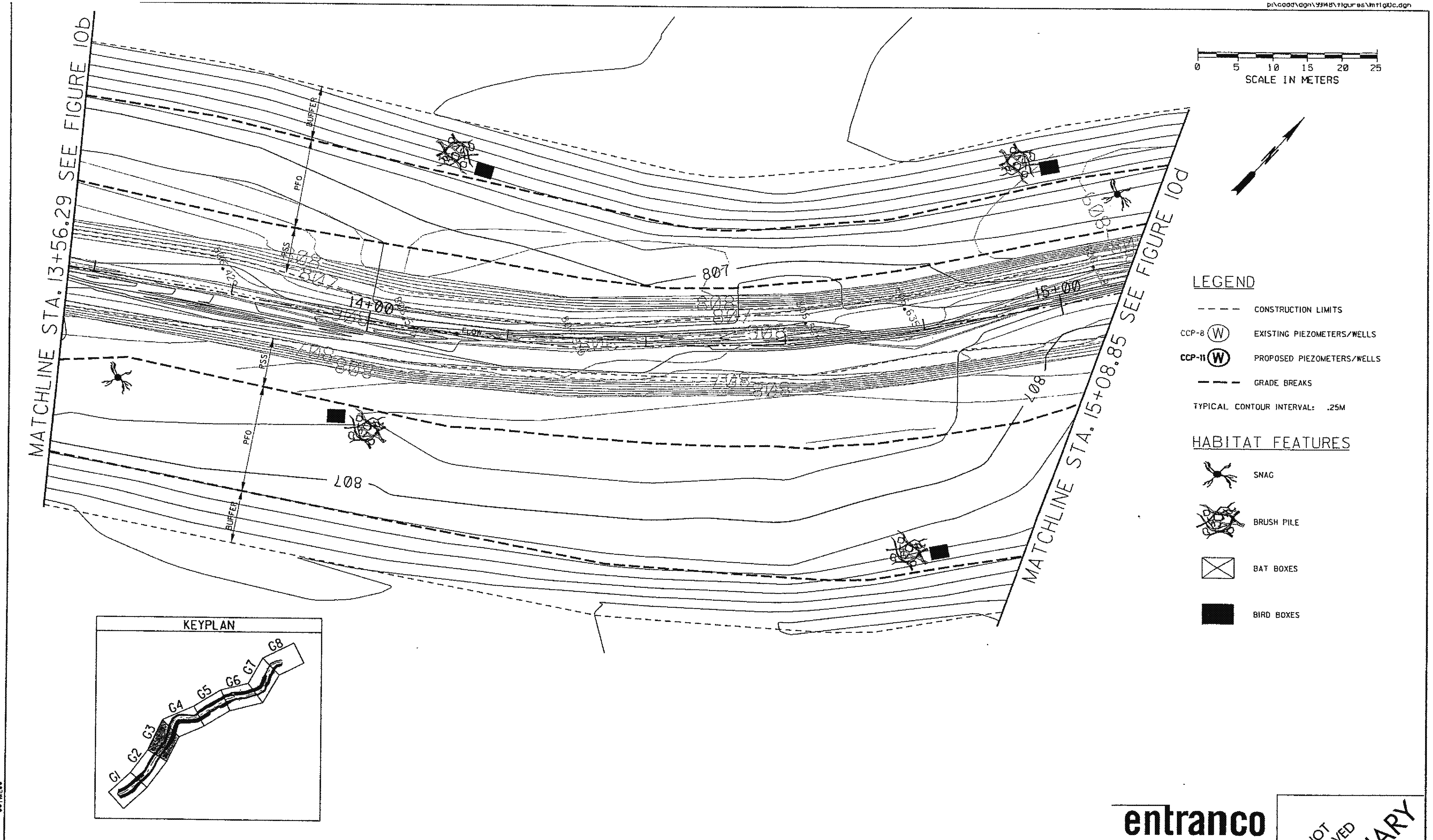

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				DETAILED	CADD FILE NAME				KEY NUMBER 7769
				DRAWING CHECKED	DRAWING DATE:				FIGURE 10c

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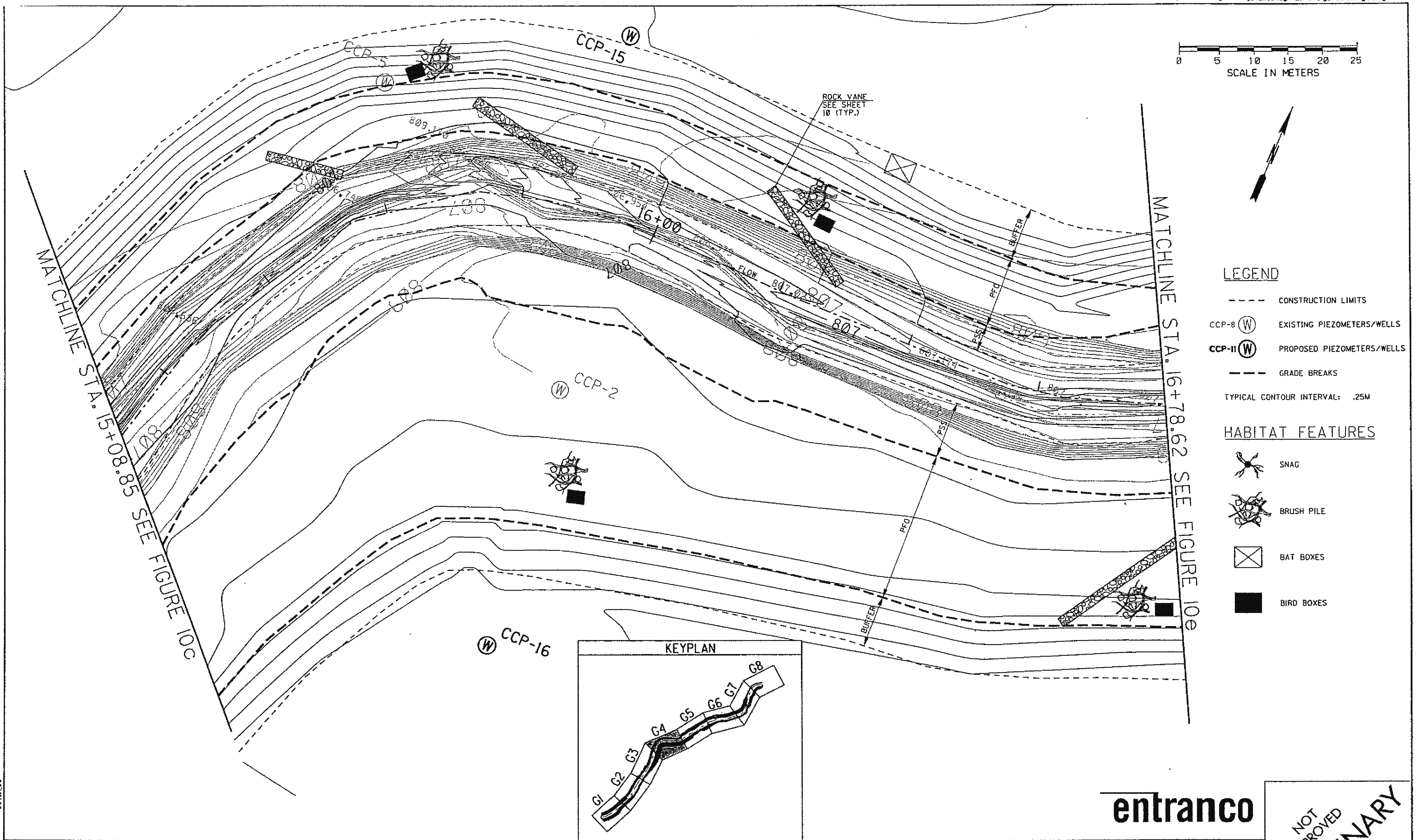

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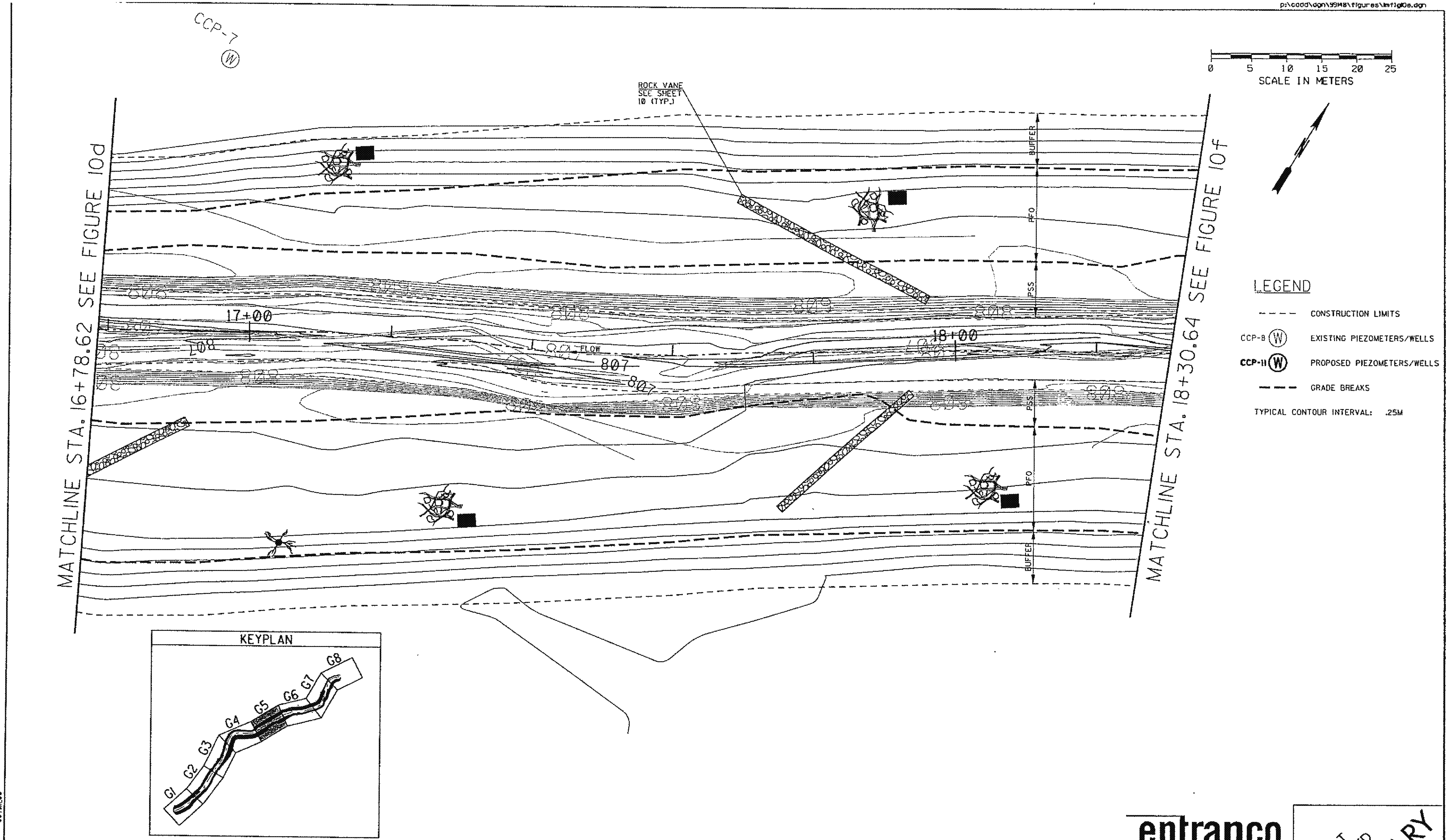
REVISIONS				DESIGNED		IDAHO TRANSPORTATION DEPARTMENT	FEDERAL AID PROJECT NO.	WETLAND MITIGATION	metric
NO.	DATE	BY	DESCRIPTION	DESIGN CHECKED			NH-4110(133)	US-95 TOP OF LEWISTON HILL TO MOSCOW G4 - GRADING PLAN	COUNTY LATAH/NEZ PERCE
				DETAILED	CADD FILE NAME				KEY NUMBER 7769
				DRAWING CHECKED	DRAWING DATE:				FIGURE 10d

12/19/2003



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				DETAILED	CADD FILE NAME			KEY NUMBER 7769
				DRAWING CHECKED	DRAWING DATE:			FIGURE 10e

12/19/2003

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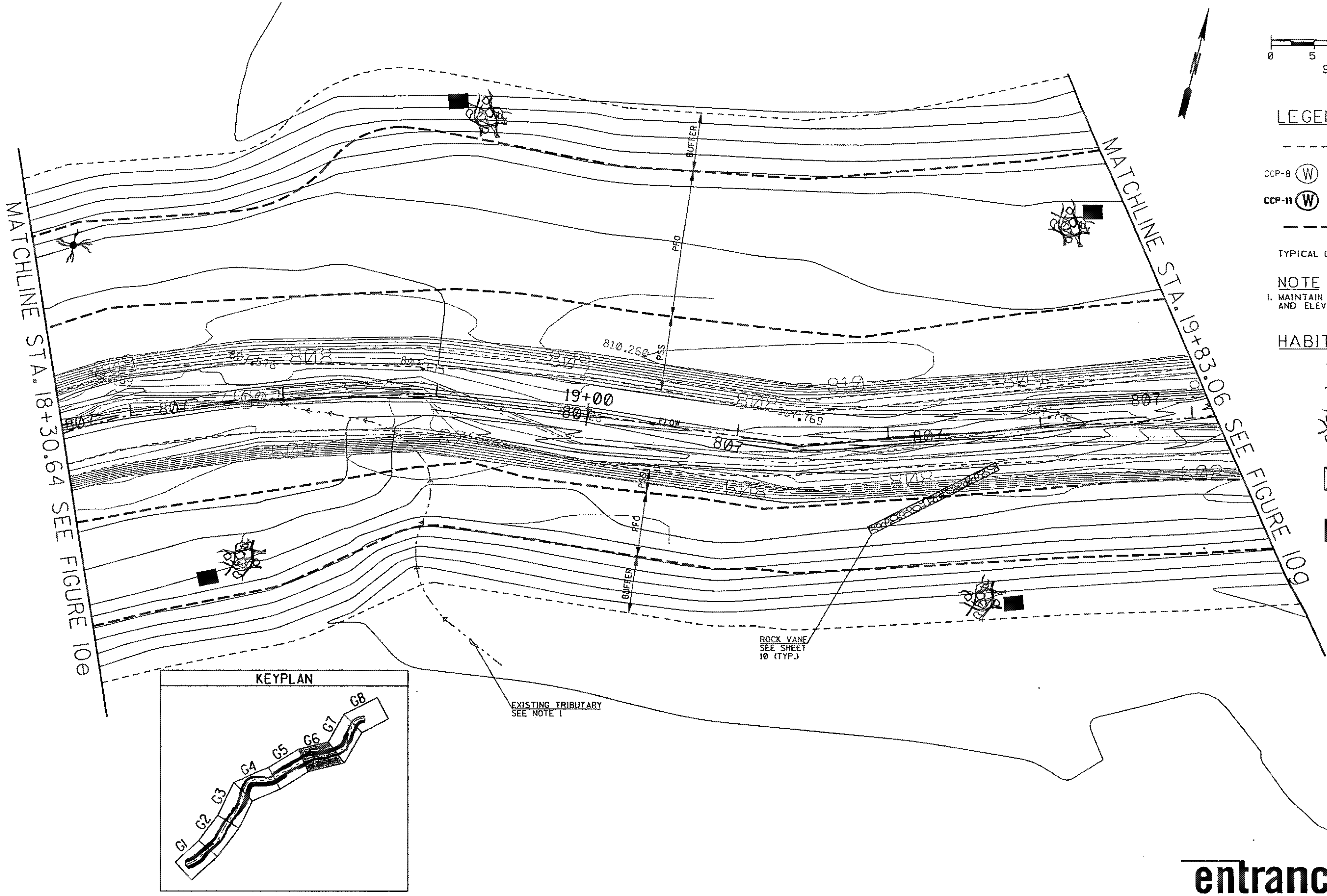

0 5 10 15 20 25
SCALE IN METERS

LEGEND

- - - - CONSTRUCTION LIMITS

CCP-8 (W) EXISTING PIEZOMETERS/WELLS

CCP-11 (W) PROPOSED PIEZOMETERS/WELLS

— — — GRADE BREAKS

TYPICAL CONTOUR INTERVAL: .25M

NOTE

1. MAINTAIN EXISTING TRIBUTARY ALIGNMENT AND ELEVATION INTO STREAM.

HABITAT FEATURES

SNAG

BRUSH PILE

BAT BOXES

BIRD BOXES

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IDAHO TRANSPORTATION DEPARTMENT

FEDERAL AID PROJECT NO.
NH-4110(133)

WETLAND MITIGATION
US-95
TOP OF LEWISTON HILL TO MOSCOW
G6 - GRADING PLAN

metric
COUNTY LATAH/NEZ PERCE
KEY NUMBER 7769
FIGURE 10f

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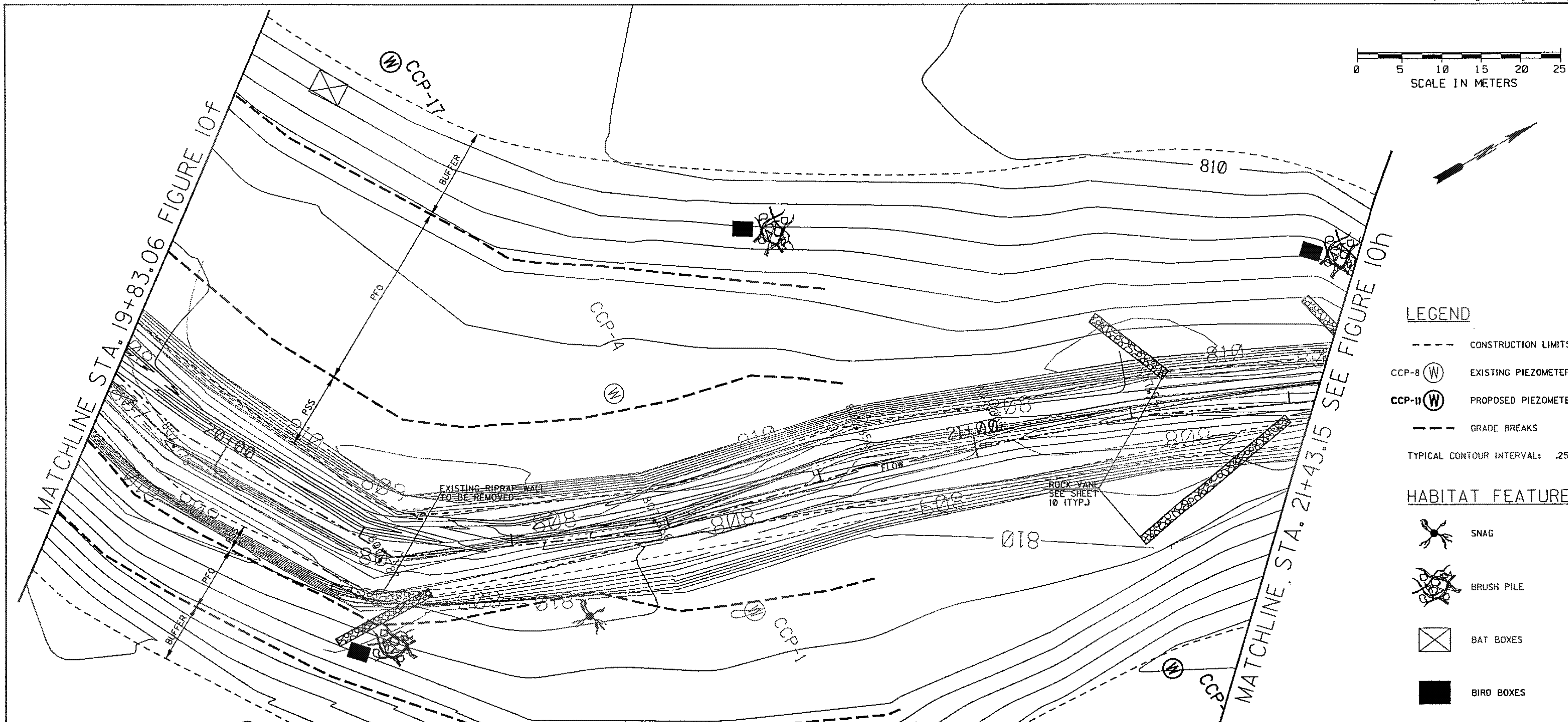


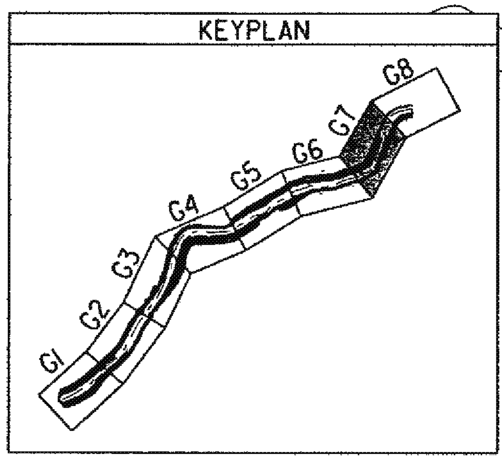
LEGEND

- CONSTRUCTION LIMITS
- CCP-8 (W) EXISTING PIEZOMETERS/WELLS
- **CCP-11 (W)** PROPOSED PIEZOMETERS/WELLS
- GRADE BREAKS

TYPICAL CONTOUR INTERVAL: .25M

HABITAT FEATURES

- SNAG
- BRUSH PILE
- BAT BOXES
- BIRD BOXES



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				DETAILED	CADD FILE NAME
				DRAWING CHECKED	DRAWING DATE:

IDAHO TRANSPORTATION DEPARTMENT

FEDERAL AID PROJECT NO.: NH-4110(133)

WETLAND MITIGATION

US-95
TOP OF LEWISTON HILL TO MOSCOW
G7 - GRADING PLAN

metric

COUNTY: LATAH/NEZ PERCE

KEY NUMBER: 7769

FIGURE 10g

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PRELIMINARY

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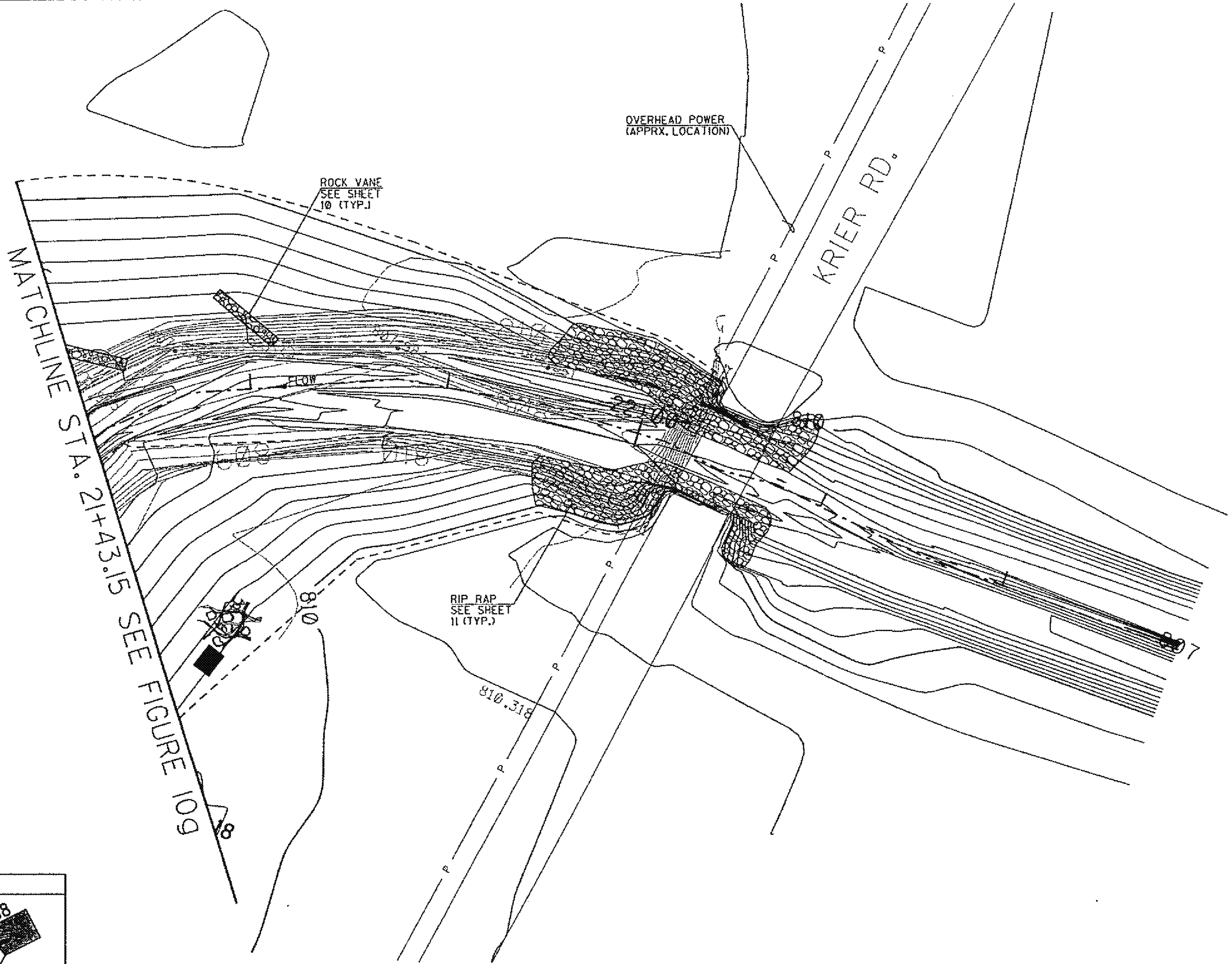


0 5 10 15 20 25
SCALE IN METERS

LEGEND

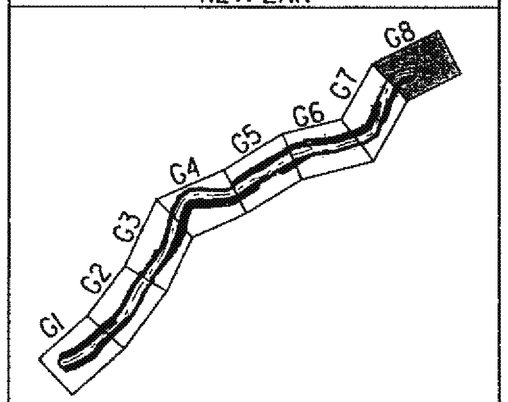
- - - - CONSTRUCTION LIMITS
CCP-6 (W) EXISTING PIEZOMETERS/WELLS
CCP-11 (W) PROPOSED PIEZOMETERS/WELLS
— — — GRADE BREAKS

TYPICAL CONTOUR INTERVAL: .25M

HABITAT FEATURES

SNAG
BRUSH PILE
BAT BOXES
BIRD BOXES

KEYPLAN



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PRELIMINARY
FOR CONSTRUCTION

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DRAWING CHECKED
CADD FILE NAME
DRAWING DATE:

IDAHO TRANSPORTATION DEPARTMENT

FEDERAL AID PROJECT NO.
NH-4110(133)

WETLAND MITIGATION
US-95
TOP OF LEWISTON HILL TO MOSCOW
G8 - GRADING PLAN

metric
COUNTY LATAH/NEZ PERCE
KEY NUMBER 7769
FIGURE 10h

12/19/2003

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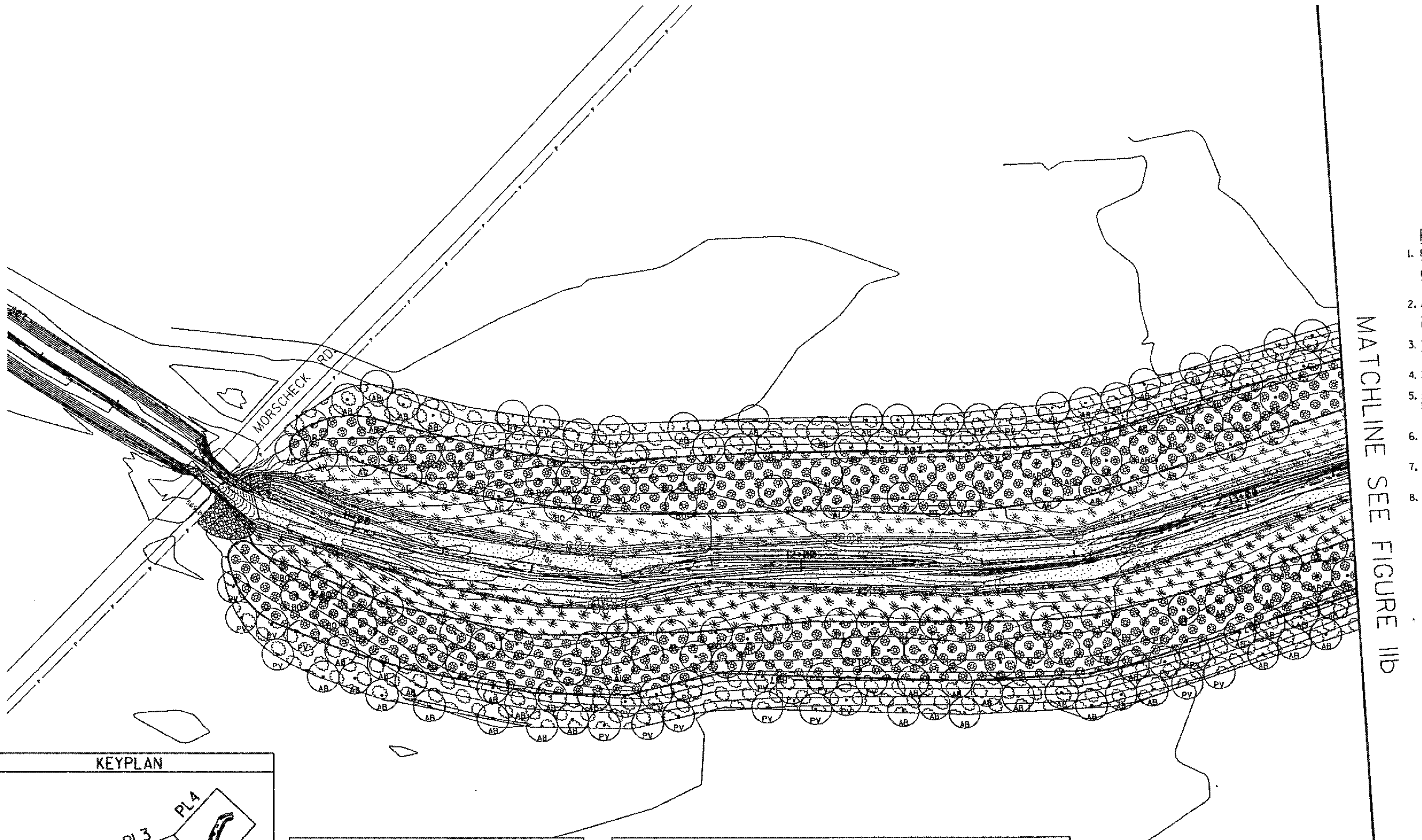
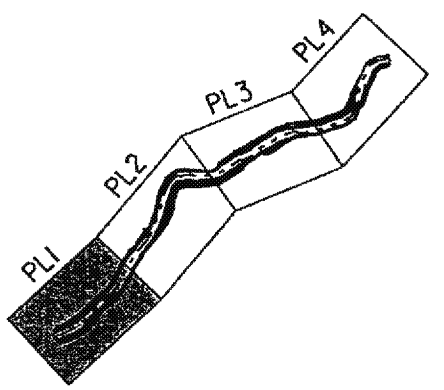


0 10 20 30 40 50
SCALE IN METERS

PLANTING NOTES:

1. PLANTS SHALL BE PLANTED IN A RANDOM, INTERMIXED LAYOUT. TRIANGULAR SPACING IS INDICATED IN LEGEND. GROUP PLANTS OF THE SAME TYPE IN ODD-NUMBERED CLUSTERS OF 3-13 PLANTS. TREES TO BE LOCATED PER PLAN AND SPECIAL PROVISIONS.
2. ANY DISCREPANCIES BETWEEN THE DRAWINGS, SPECIFICATIONS AND/OR SITE CONDITIONS SHALL BE BROUGHT TO THE ATTENTION OF THE FIELD ENGINEER PRIOR TO PRECEDING WITH CONSTRUCTION.
3. THE CONTRACTOR IS RESPONSIBLE FOR LOCATION UTILITIES PRIOR TO BEGINNING CONSTRUCTION.
4. INSTALL COIR MATTING PRIOR TO PLANTING.
5. SEE TEMPORARY AND PERMANENT EROSION CONTROL DRAWINGS FOR EROSION CONTROL REQUIREMENTS AND LIMITS OF CLEARING AND GRADING.
6. HIGH VISIBILITY FENCE TO REMAIN IN PLACE THROUGHOUT PLANT ESTABLISHMENT PERIOD AS DIRECTED BY THE FIELD ENGINEER.
7. CONTRACTOR SHALL ATTACH A "NAME TAG" (COMMON NAME) TO EACH GROUPING OF PLANTS FOR IDENTIFICATION.
8. SEE DETAILS FOR PLANTING REQUIREMENTS.

KEYPLAN



PLANTING LEGEND

	BUFFER
	PFO - FORESTED
	PSS - SCRUB SHRUB
	PFO - ENHANCEMENT

TREE SYMBOLS

AB	ABIES GRANIS	AR	ALNUS RUBRA
PV	PRUNUS VIRGINIANA	BO	BELUTA OCCIDENTALIS
AG	ACER GLABRUM	PT	POPULUS TREMULOIDES
AI	ALNUS INCANA		

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PRELIMINARY

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IDAHO TRANSPORTATION DEPARTMENT

FEDERAL AID PROJECT NO.: NH-4110(133)

WETLAND MITIGATION
US-95
TOP OF LEWISTON HILL TO MOSCOW
FIGURE 11a

metric
COUNTY: LATAH/NEZ PERCE
KEY NUMBER: 7769
FIGURE: 11a

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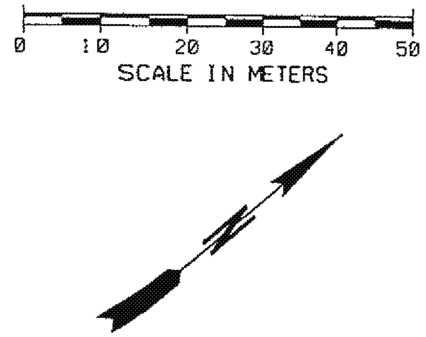

PLANTING NOTES:

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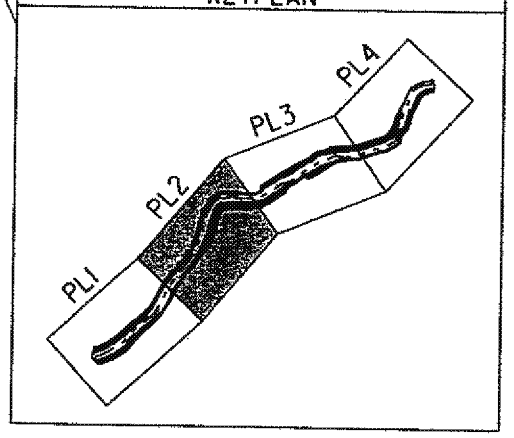
8. SEE DETAILS FOR PLANTING REQUIREMENTS.

KEYPLAN



PLANTING LEGEND

- BUFFER
- PFO - FORESTED
- PSS - SCRUB SHRUB
- PFO - ENHANCEMENT

TREE SYMBOLS

AB	ABIES GRANIS	AR	ALNUS RUBRA
PV	PRUNUS VIRGINIANA	BO	BELUTA OCCIDENTALIS
AG	ACER GLABRUM	PT	POPULUS TREMULOIDES
AI	ALNUS INCANA		

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DRAWING CHECKED
CADD FILE NAME
DRAWING DATE:

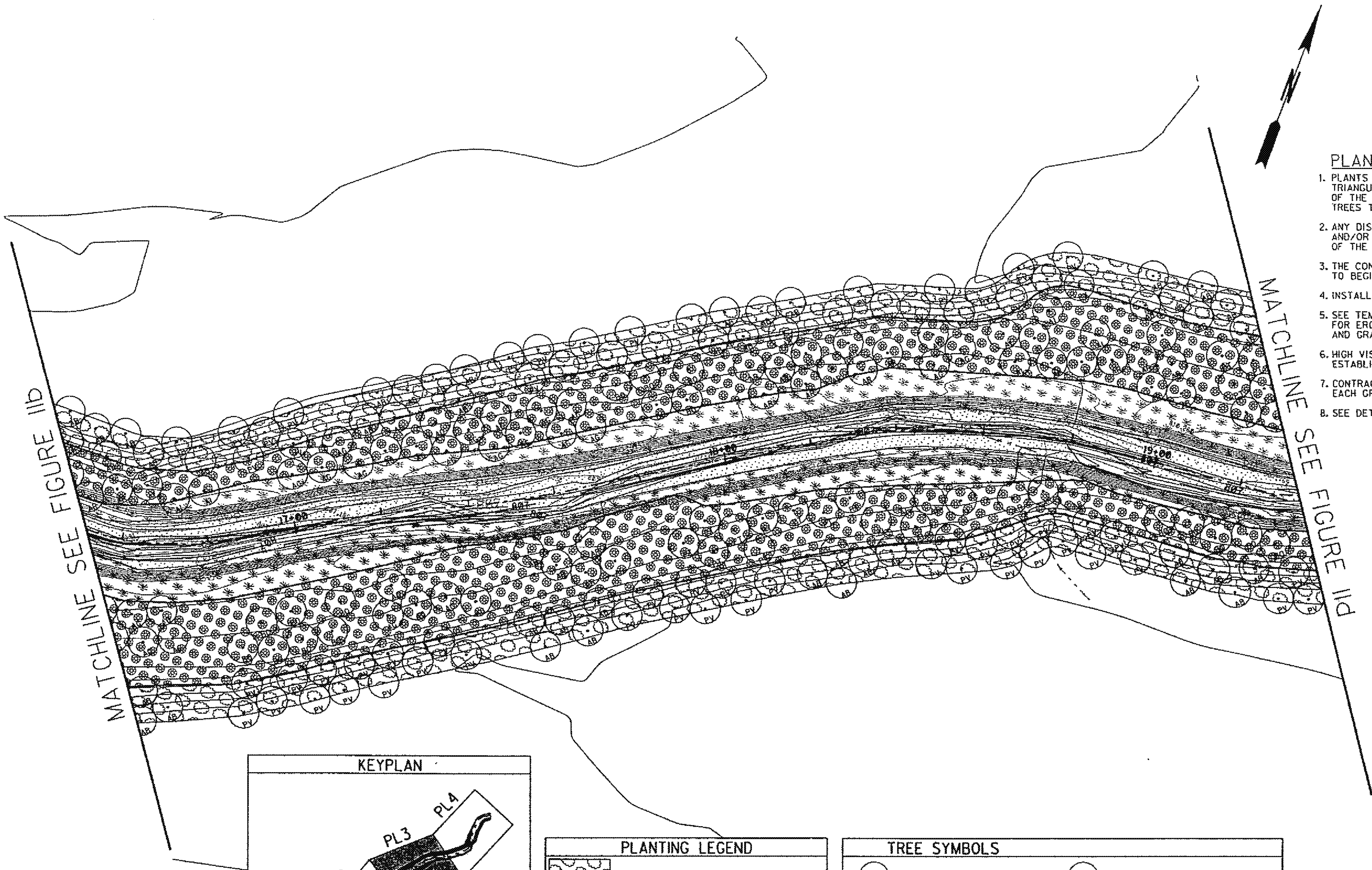
IDAHO TRANSPORTATION DEPARTMENT

FEDERAL AID PROJECT NO.
NH-4110(133)

WETLAND MITIGATION
US-95
TOP OF LEWISTON HILL TO MOSCOW
FIGURE IIb

metric
COUNTY LATAH/NEZ PERCE
KEY NUMBER 7769
FIGURE IIb

12/19/2003



0 10 20 30 40 50
SCALE IN METERS

PLANTING NOTES:

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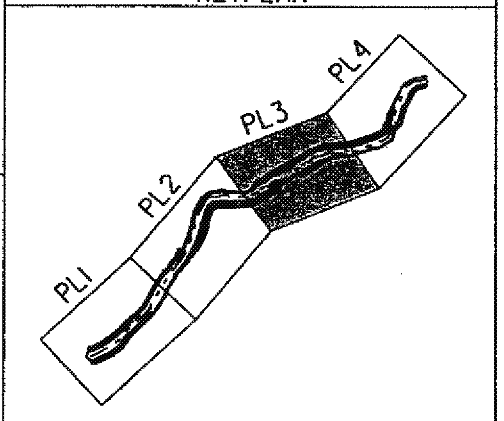
KEYPLAN



PLANTING LEGEND

- BUFFER
- PFO - FORESTED
- PSS - SCRUB SHRUB
- PFO - ENHANCEMENT

TREE SYMBOLS

AB	ABIES GRANIS	AR	ALNUS RUBRA
PV	PRUNUS VIRGINIANA	BO	BELUTA OCCIDENTALIS
AG	ACER GLABRUM	PT	POPULUS TREMULOIDES
AI	ALNUS INCANA		

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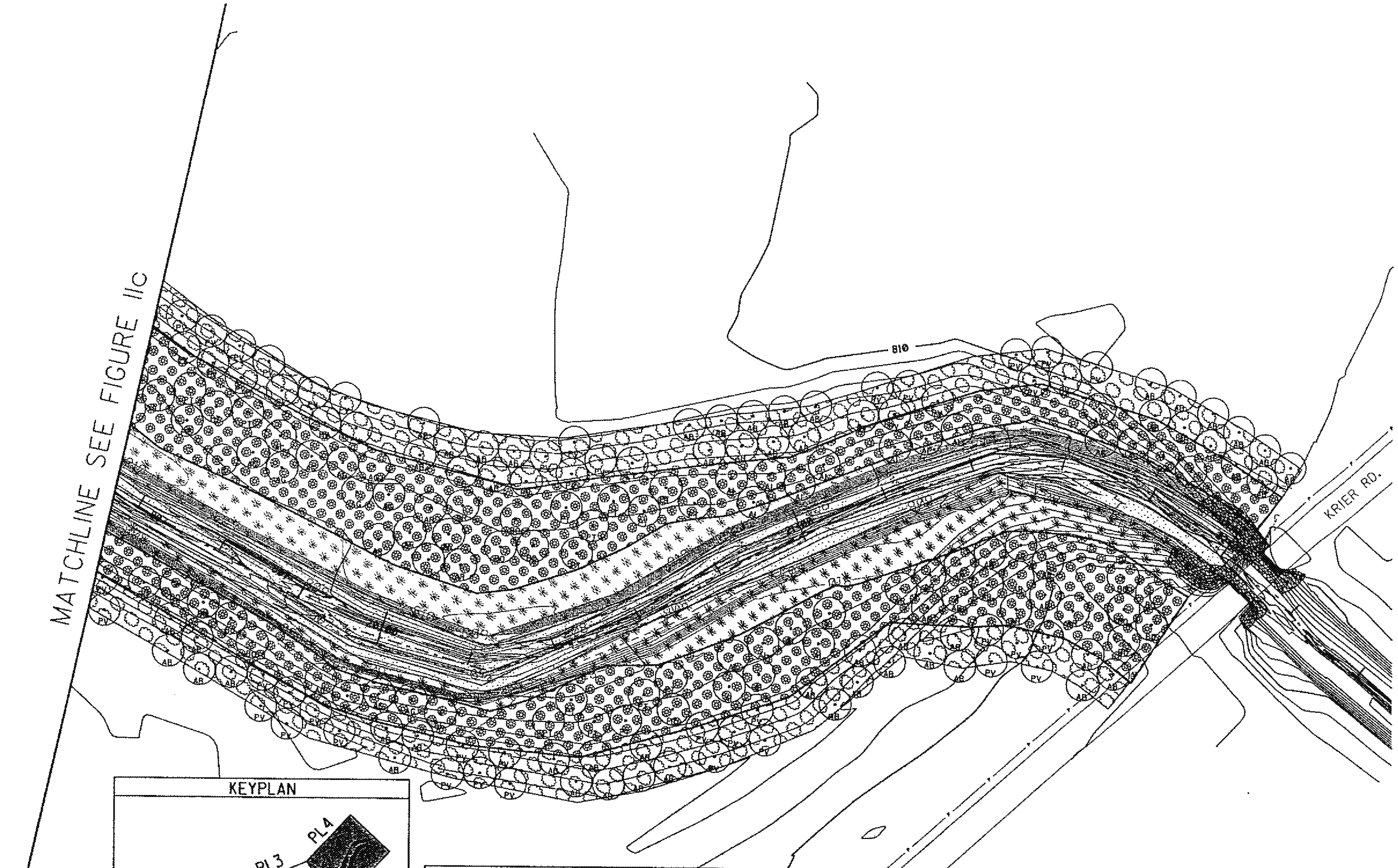
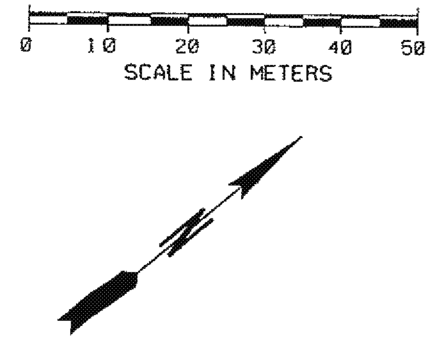
				DESIGN CHECKED			NH-4110(133)	US-95 TOP OF LEWISTON HILL TO MOSCOW FIGURE IIc
				DETAILED	CADD FILE NAME			
				DRAWING CHECKED	DRAWING DATE:			

metric
COUNTY LATAH/NEZ PERCE
KEY NUMBER 7769
FIGURE IIc

12/19/2003





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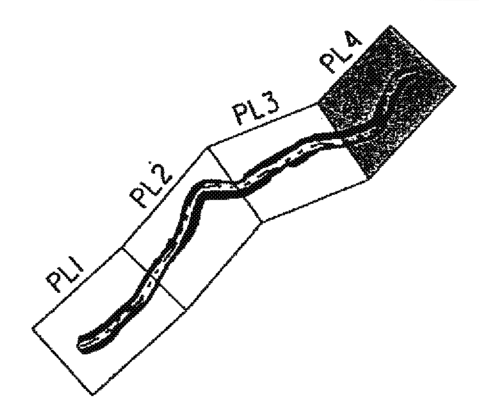
8. SEE DETAILS FOR PLANTING REQUIREMENTS.

KEYPLAN



PLANTING LEGEND

- BUFFER
- PFO - FORESTED
- PSS - SCRUB SHRUB
- PFO - ENHANCEMENT

TREE SYMBOLS

AB	ABIES GRANIS	AR	ALNUS RUBRA
PV	PRUNUS VIRGINIANA	BO	BELUTA OCCIDENTALIS
AG	ACER GLABRUM	PT	POPULUS TREMULOIDES
AI	ALNUS INCANA		

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DRAWING DATE:

IDAHO TRANSPORTATION DEPARTMENT

FEDERAL AID PROJECT NO.: NH-4110(133)

WETLAND MITIGATION

US-95
TOP OF LEWISTON HILL TO MOSCOW
FIGURE IId

metric

COUNTY: LATAH/NEZ PERCE

KEY NUMBER: 7769

FIGURE: 11d

Hydrology

Establishing the wetland hydrology is the most critical factor to mitigation success. The "Existing Conditions" section, above, describes the groundwater hydrology and the stream-groundwater interaction. The results of the field investigations indicate that groundwater is available to the wetlands during the entire year via flow through the bedrock aquifer and, to a lesser degree, the overlying clay layer. This has been demonstrated by the continuous presence of several feet of groundwater in piezometers that were installed both proximal and distal to the stream channel (Table 6; Figure 12a – 12e)

During the field visits, there was no active groundwater discharge from the top of the clay layer into the stream down most of its length. Near the downstream limit of the project, groundwater, presumed to be from the sewage lagoons, is actively flowing out of the clay layer. The clay stratum is perforated with roots and animal burrows that have subsequently filled with the less-permeable loess. It appears that water is migrating in significant quantities through the clay and onto the top of the bedrock, thus providing recharge from direct precipitation over the entire project area. The base of the stream channel lies atop the bedrock and is connected with the stream at this point, as evidenced by the presence of water in most of the base-flow channel throughout the year.

Soils

Wetland areas will be excavated out of the existing soils. The soils along Cow Creek are mapped as Latahco silt loam 0 to 3 percent slope and Westlake-Latahco silt loam 0 to 3 percent slope (NRCS 1993) (USDA SCS 1981). Both are hydric soils (E. Haagen, personal communication). A more complete on-site characterization of the soils must be completed before wetland construction. If the subsoil on the site is found to be of a fine texture and sufficient to retain water, the subsoil will be retained and used as the wetland base. Low-permeability subsoil will be topped with one or two feet of topsoil to support wetland plants.

Vegetation

The mitigation areas will be planted with native wetland and buffer plants (see table 5). Plant species were chosen based on typical plant species found along riparian areas in the meadow steppe region.

The vegetation communities along the existing riparian wetlands in the region are dominated by Douglas hawthorn (*Crataegus douglasii*) and

Table 6

Piezometer #	# 1	# 2	# 3	# 4	# 5	# 6	# 7	# 8	# 9	# 10	West Bridge	East Bridge
measuring point elevations	810.84	809.63	810.61	810.46	809.60	809.55	810.00	808.35	808.70	808.59	809.05	811.32
3/14/03	808.62	807.72	809.21	808.62	807.84	808.43	807.97	806.65	807.12	807.25		810.20
4/1/03	808.54	807.57	809.11	808.48	807.69	807.64	807.79	806.55	807.00	807.52	805.42	808.22
4/17/03	808.34	807.41	808.83	808.15	807.48	807.97	807.62	806.42	806.71	807.33	805.44	808.00
5/1/03	808.24	807.31	808.68	808.16	807.36	807.78	807.52	806.36	806.62	807.24	805.43	807.90
5/15/03	808.11	807.53	808.53	808.05	807.28	807.67	807.43	806.58	806.53	807.48	805.37	807.81
6/1/03	807.89	807.04	808.16	807.79	807.02	807.43	807.24	806.09	806.34	806.90	805.26	807.72
6/25/03	807.74	806.89	807.94	807.59	806.92	807.20	807.08	805.97	806.16	806.85	809.05	811.32
7/11/03	807.49	806.76	807.51	807.39	806.74	806.64	806.93	805.83	805.98	806.58	809.05	811.32
7/25/03	807.30	806.63	807.26	807.17	806.64	806.79	806.81	805.81	805.89	806.01	809.05	811.32
8/12/03	807.07	806.62	807.21	807.08	806.64	806.74	806.79	805.80	805.96	806.06	809.05	811.32
8/27/03	807.07	806.61	807.24	806.83	806.64	806.78	806.77	805.75	805.94	806.15	809.05	811.32
9/9/03	807.09	806.64	808.40	807.08	806.65	806.80	806.75	805.80	805.99	806.19	809.05	811.32

Table 6
Static water levels measured from March through September 2003 in piezometers along a reach of Cow Creek, Genesee, Idaho.

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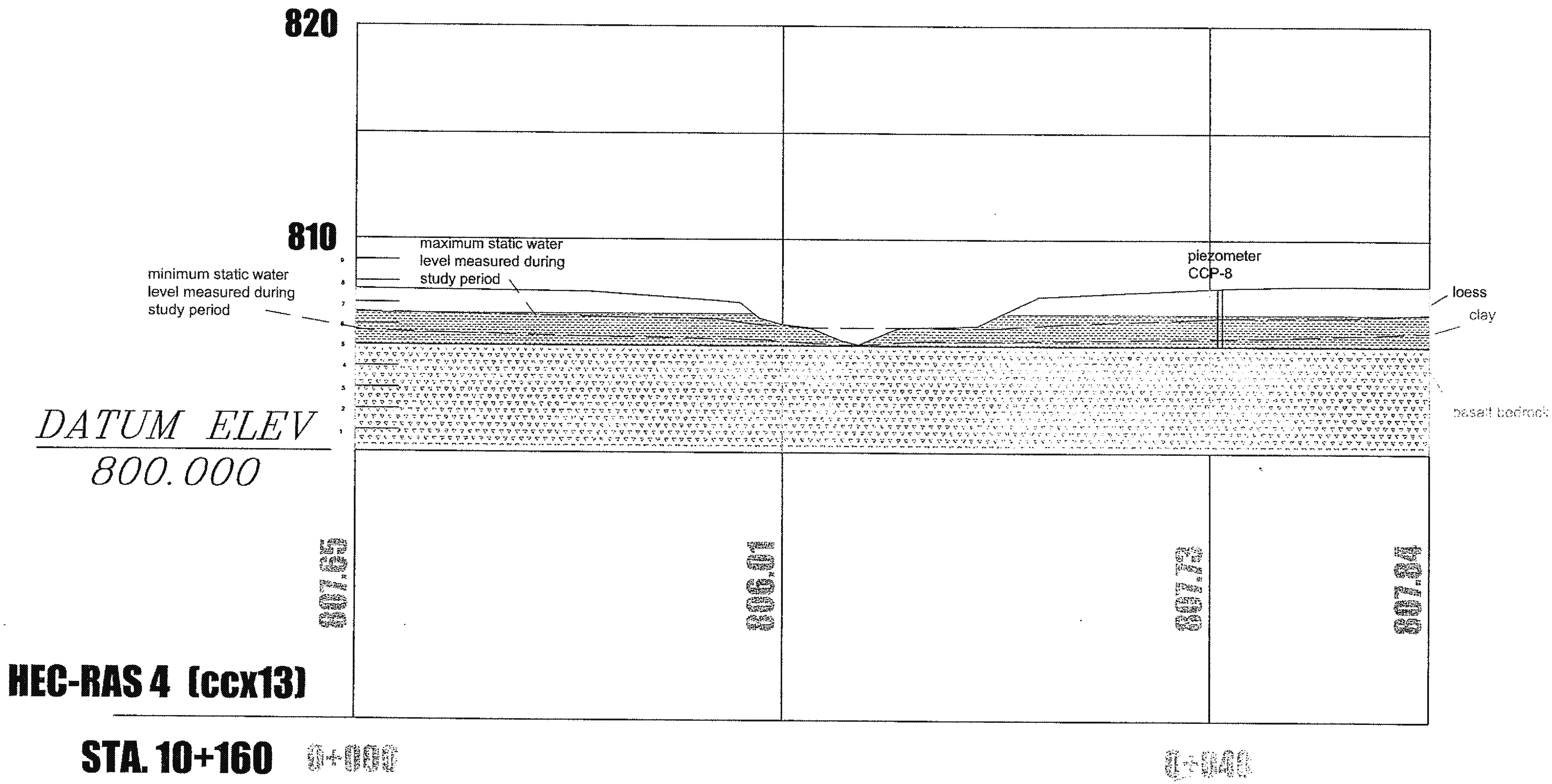
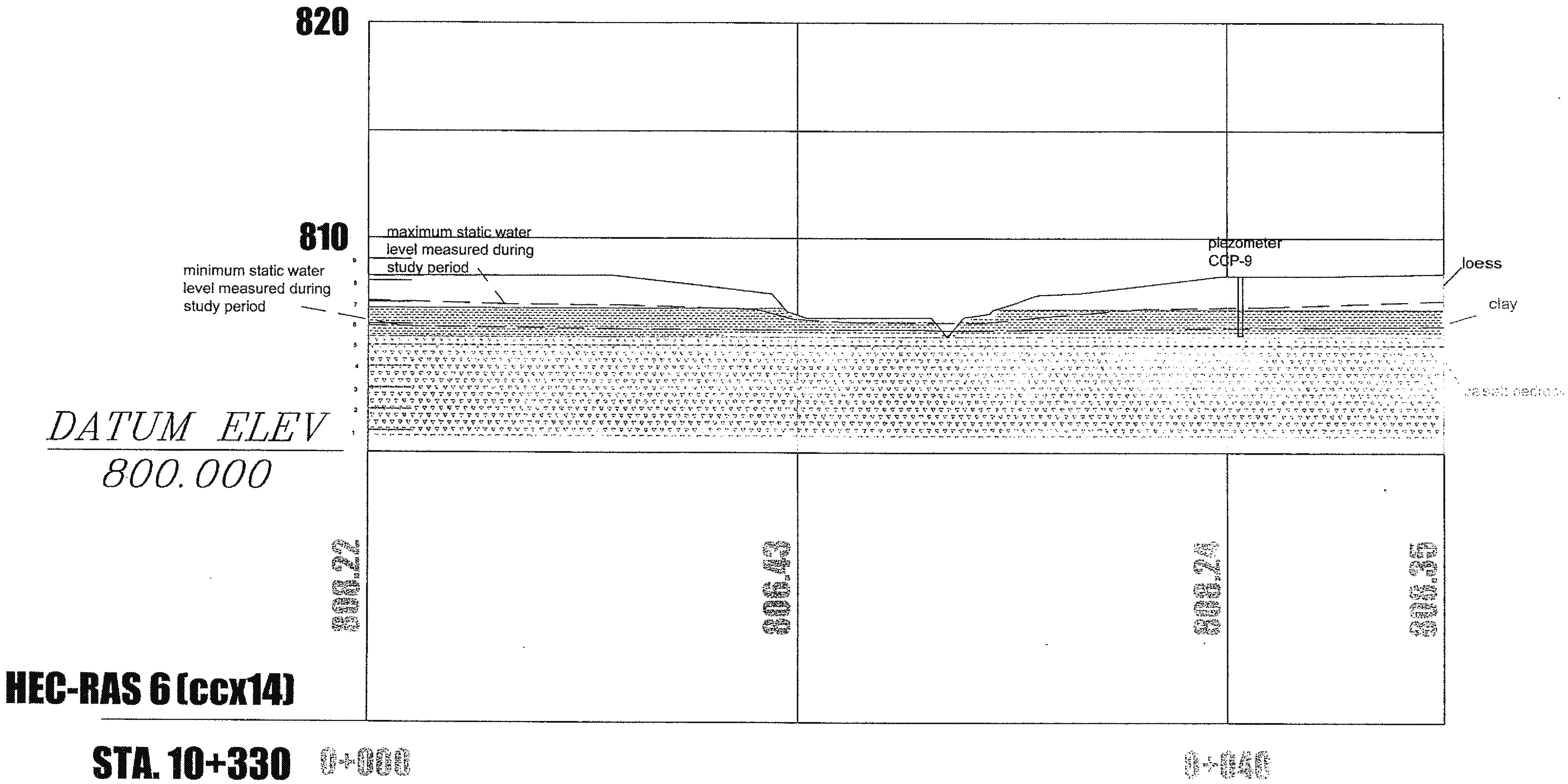


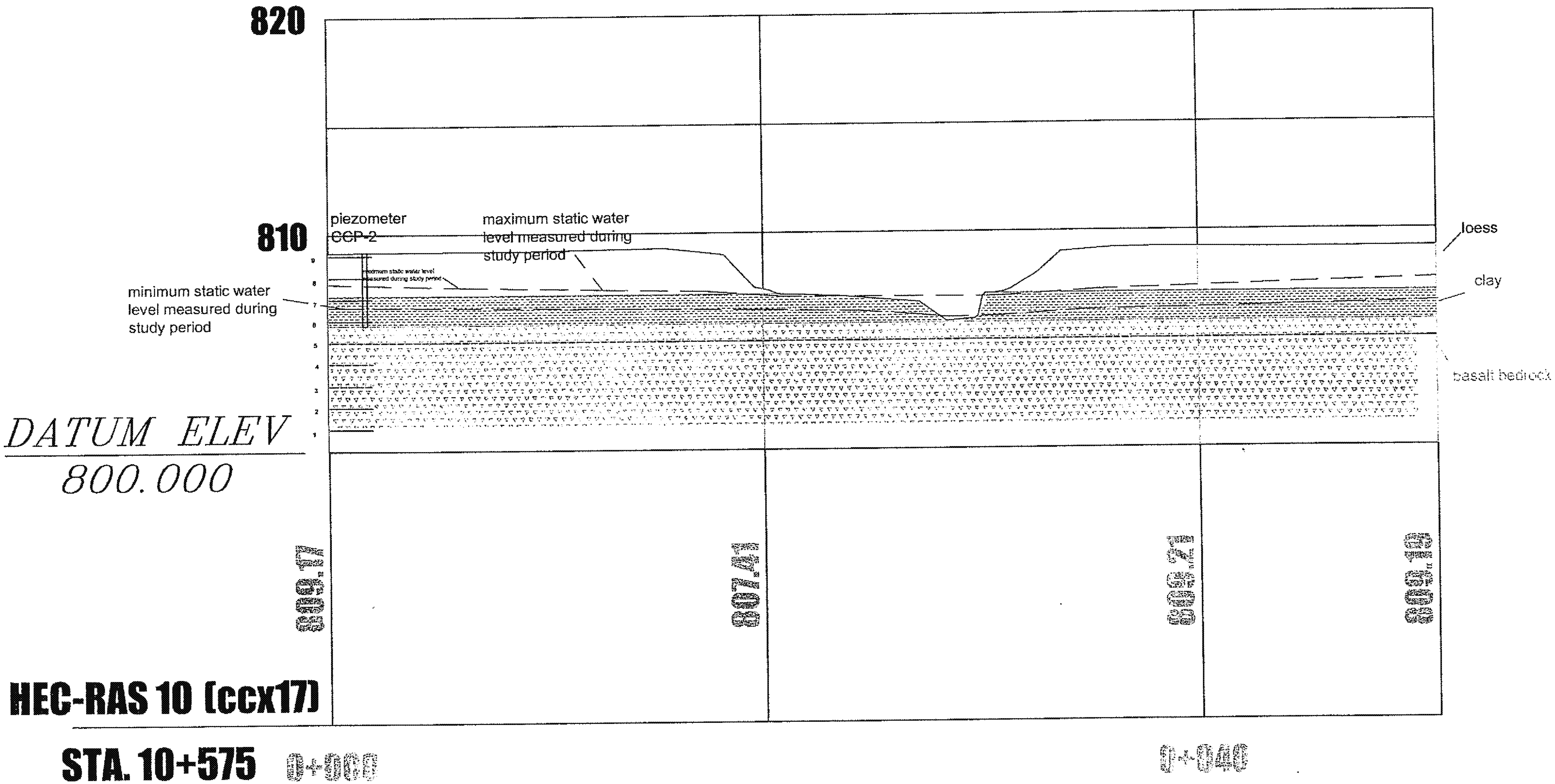
Numeral indicates HEC-RAS cross section; CCX number indicates field cross section station;
Station number is Imperial stationing initially assigned on channel centerline.

Figure 12 A. Hydrogeological cross section CCX-13 at Cow Creek, Genesee, Idaho



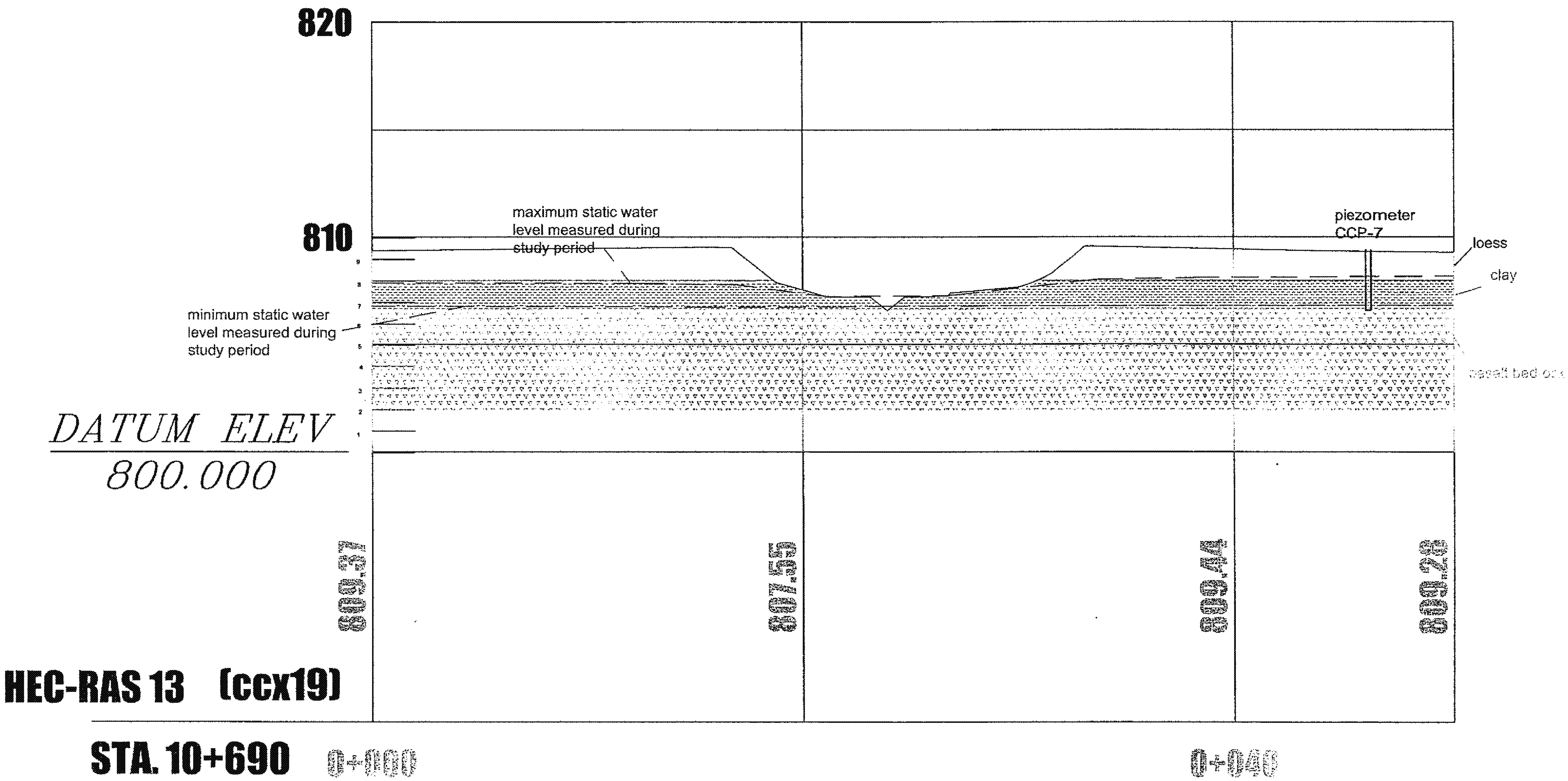
Numeral indicates HEC-RAS cross section; CCX number indicates field cross section station;
Station number is Imperial stationing initially assigned on channel centerline.

Figure 12 B. Hydrogeological cross section CCX-14 at Cow Creek, Genesee, Idaho



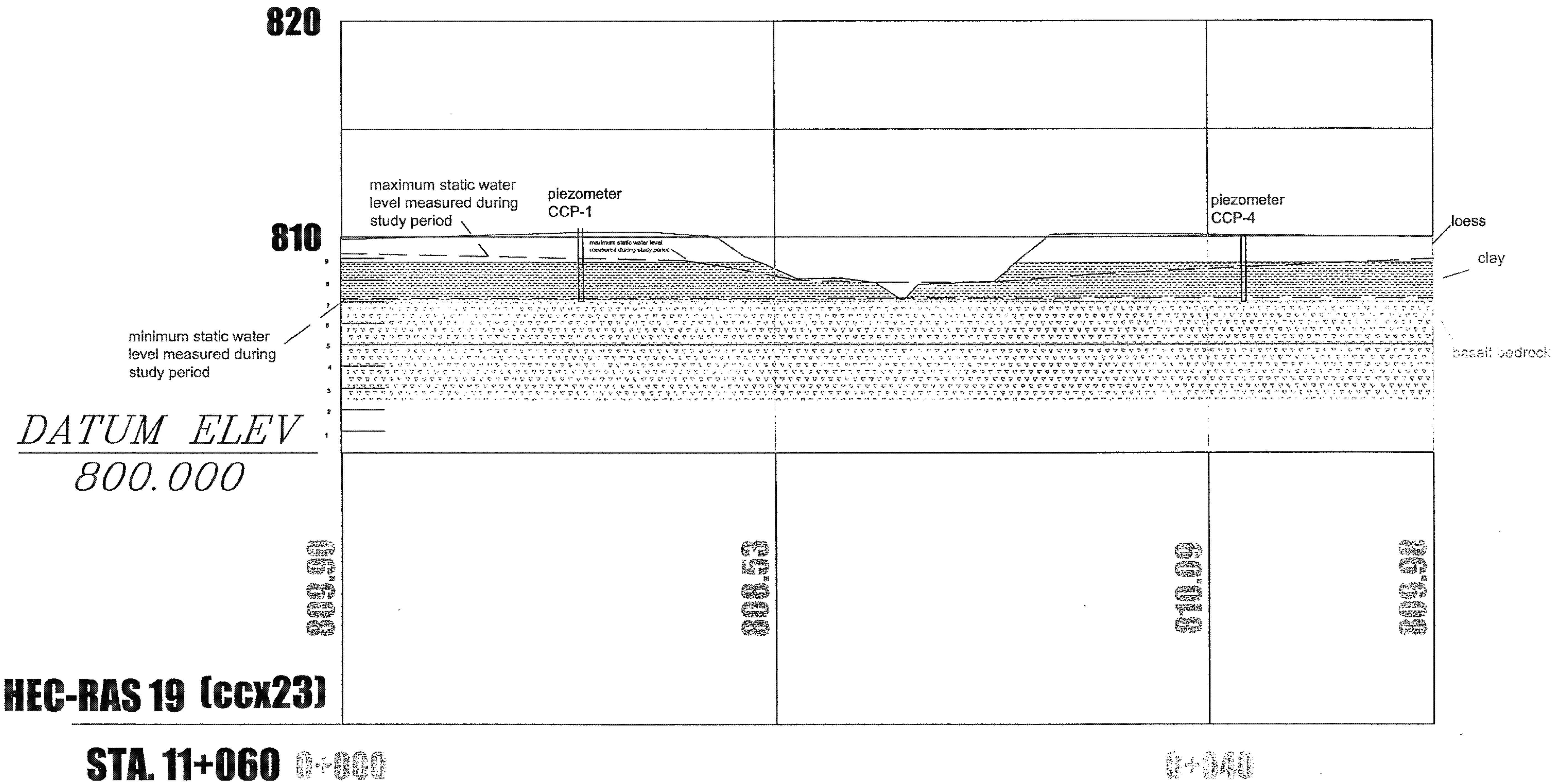
Numeral indicates HEC-RAS cross section; CCX number indicates field cross section station; Station number is Imperial stationing initially assigned on channel centerline.

Figure 12 C. Hydrogeological cross section CCX-17 at Cow Creek, Genesee, Idaho



Numeral indicates HEC-RAS cross section; CCX number indicates field cross section station; Station number is Imperial stationing initially assigned on channel centerline.

Figure 12 D. Hydrogeological cross section CCX-19 at Cow Creek, Genesee, Idaho



Numeral indicates HEC-RAS cross section; CCX number indicates field cross section station;
Station number is Imperial stationing initially assigned on channel centerline.

Figure 12 E. Hydrogeological cross section CCX-23 at Cow Creek, Genesee, Idaho associated species. This community association was used as a reference to determine typical plant species native to the area (Franklin and Dyrness 1988).

The plantings will be placed based on preference and tolerance for soil saturation. Hydrophytic plants will be placed in the low-lying areas where inundation is expected at higher frequency and duration. Plants with less tolerance for flooded or inundated conditions will be planted on higher elevations within the wetland mitigation areas. Plants will be supplied as balled and burlapped or in containers for trees and in bare root or containers for shrubs. Dogwood may be stakes. Emergent wetland plants will be planted from containers or plugs.

Trees will typically be planted on 15-foot centers. Shrubs will be planted at a distance ranging from 3 to 5 feet apart. Herbaceous groundcover will be planted from 12 inches to 36 inches apart. All plants will be placed in copses of odd numbers from five to thirteen individuals of like species.

Construction

Construction plans will include grading and planting plans, and will include provisions that construction material will not be stored in existing or new wetland areas. Staging areas will be located in areas where the wetlands will not be affected.

Implementation Schedule

To reduce the likelihood of erosion and sediment runoff, grading and topsoil placement should occur during dry summer months. Plants should be installed during plant dormancy, which generally occurs in late September or early October. Plant survival monitoring will take place the following fall towards the end of the growing season before plants have gone dormant. Replantings to meet the contractor warranty will take place before spring while the plants are still dormant. Vegetation percent cover monitoring will then take place in late spring and continue annually for years one, two, three, five, seven, and ten. Hydrology and soil monitoring will take place annually until wetland soils and hydrology criteria are determined to be successful.

Erosion Control and Water Quality Protection

Temporary erosion and sedimentation measures will be put in place prior to grading activities. Vegetation cleared during construction will be replanted to prevent continued sediment runoff.

Also, a SWPPP, prepared jointly by ITD and the Contractor, would be implemented prior to construction. The SWPPP would define the limits of clearing and grading; show the location of silt fencing; establish an excavation window, as necessary; outline methods to stabilize disturbed soils; construct sediment trapping devices; collect and treat runoff; and implement other BMPs necessary to meet state water quality standards. The SWPPP would also include an emergency response plan to address management measures for oil, gasoline, and solvents used in the operation and maintenance of vehicles and machinery.

Functions and Values

Wetland functions and values were assessed using the Montana Department of Transportation's *Montana Wetland Assessment Method* (Western EcoTech 1999) for the mitigation site before and after the proposed mitigation.

The mitigated wetlands are designed to be contiguous with the existing wetlands present along Cow Creek. Impacts to the existing wetlands will be avoided.

The existing wetlands generally score low with a total Actual Functional Points of 4.0 out of 12. The proposed wetlands will score medium to high with total Actual Functional Points of 7.6 out of 12 as shown in table 7.

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Table 7
Functions and Values Assessment Summary

Functions and Values Variables	Existing Rating	Existing Actual Functional Points	Proposed Rating	Proposed Actual Functional Points
A. Listed/Proposed T&E Species Habitat	L	0	L	0
B. MT Natural Heritage Program Species Habitat	L	0	L	0
C. General Wildlife Habitat	L	0.1	H	0.9
D General Fish/Aquatic Habitat	L	0.1	L	0.1
E. Flood Attenuation	L	0.1	H	0.9
F. Short and Long Term Surface Water Storage	L	0.3	H	0.8
G. Sediment/Nutrient/Toxicant Removal	M	0.4	M	0.4
H. Sediment/Shoreline Stabilization	H	1.0	H	1
I. Production Export/Food Chain Support	M	0.7	H	1
J. Groundwater Discharge/Recharge	H	1.0	H	1
K. Uniqueness	L	0.2	M	0.5
L. Recreation/Education Potential	L	0.1	H	1
Totals		**4.0**		**7.6**

Objectives, Performance Standards, and Monitoring

Goals, objectives, performance standards, and monitoring criteria have been determined for the wetland mitigation project.

Goal 1: Create Palustrine Wetland

The mitigation goal is to create a palustrine wetland with forested, scrub-shrub, and emergent components. The mitigation plan will enhance 2.02 acres of palustrine emergent (PEM) wetland. The plan also includes creation of 3.98 acres of palustrine scrub/shrub (PSS) and 7.51 acres of palustrine forested (PFO) wetland; a total of 11.49 acres of wetland creation. The mitigation requirements for Alternative 10A require 9.50 acres of creation (see table 4): 3.93 acres of PEM, 4.99 acres of PFO and 0.57 acre of non-jurisdictional wetlands, based on impacts to these types of wetland. No PSS wetlands are being impacted; therefore, no PSS creation is required for mitigation. Existing upland areas along Cow Creek will be excavated and planted to create wetland areas.

Monitoring should be performed in years one, two, three, five, seven, and ten after construction to determine if the performance standards have been met. If the performance standards have not been met, contingencies should be implemented.

Objective 1: Establish wetland hydrology.

Establish wetland hydrology—soils saturated to the surface during the growing season in the wetland areas.

Performance standard: The wetland mitigation area will have soils saturated to the surface for a minimum of 12.5 percent of the growing season (May to September) in a typical hydrologic year.

Monitoring: Long-term measurement of hydrology will be achieved by measuring the successful establishment of wetland vegetation. Also, groundwater monitoring should continue during and after construction—particularly during spring and summer to determine water availability for plants.

Contingency: Evaluate probable causes for lack of wetland hydrology and develop appropriate corrective actions, which may include regrading the site, using a clay or geotextile liner, or rerouting surface runoff.

Objective 2: Establish native wetland plant community.

Plant native wetland plants to increase species diversity and create wetland communities typical of the meadow steppe region. Limit growth of nonnative invasive plant species.

Performance Standard: *Saplings, Shrubs, and Trees* – In the first year after planting, 75 percent survival of the plantings will be required. In year three, 60 percent cover will be required. At least 80 percent cover in the mitigation area will be required after five years. *Emergents* – 75 percent survival should be required in the first year after planting; 50 percent coverage should be maintained in the third year after planting; and 80 percent cover in the fifth year. Native plants will comprise no less than 80 percent cover after 5 years.

Monitoring: *Percent survival measurement* – After installation, the woody-stemmed plants will be flagged and plots of herbaceous plants will be identified. Monitoring will involve counting the number of tagged plants and herbaceous plants that survive in sampling plots. Percent survival will be calculated by dividing the number of survivors by the number planted. The entire mitigation area will be photographed from predetermined and permanent photo-stations. *Percent cover* – Sampling plots will be chosen along permanent transects established in the wetland mitigation area the first

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year after planting. These same plots will be monitored annually. The percent cover of each plant strata (tree, shrub, herb, vine) will be estimated visually. The percent coverage of nonnative and invasive plant species will be determined separately.

The entire mitigation area will be photographed from predetermined and permanent photo-stations showing a specified viewpoint, i.e., north, south, east, west.

Contingency: Evaluate probable causes of stress to plantings and develop appropriate corrective actions, which may include replanting or relocating plants, planting different species, installing shade structures, performing additional maintenance, additional soil amendments, erecting fencing to prevent wildlife grazing, or rerouting surface runoff. If invasive plants are found to have greater than 20 percent cover, maintenance crews will remove the invasive plants by hand or with direct application of an approved chemical herbicide such as Rodeo.

Objective 3: Provide soils conducive to wetland plants.

The soil in the mitigation site should be of a texture and chemical composition that holds sufficient water and provides sufficient nutrients to support wetland vegetation. Soil treatments needed during construction will be determined by existing on-site conditions. If grading exposes native wetland topsoil, the topsoil will be retained and used to construct the mitigation areas. If grading does not expose native wetland topsoil, the top 12 inches of existing soil will be removed and replaced with silt or loam soils. The existing soil conditions must be studied to determine the exact need for soil augmentation.

Performance Standard: Soil in the mitigation area will have a loam, silt loam, or peat texture and contain at least 25 percent organic material in the top 12 to 18 inches following construction.

Monitoring: After construction, ten soil pits, sites selected at random, will be dug to 12 inches and examined for soil texture and consistency. At least 80 percent of the top 12 inches will be silt, loam, or peat soils conducive to wetland creation.

Contingency: Evaluate probable causes for lack of required texture and chemistry and develop appropriate corrective actions, which may include additional soil amendments or regrading.

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Goal 2: Establish 25-foot Stream and Wetland Buffer

The goal is to establish a buffer for Cow Creek and the wetland mitigation areas. The buffer will be protected from disturbance to minimize impacts to the wetland areas from adjacent land uses including agriculture and transportation. Buffer grasses decrease stormwater runoff velocity, reducing scour and allowing sediments and associated pollutants to drop out of the water before it enters the stream.

Performance Standard: A band of undisturbed vegetation at least 25 feet wide will be maintained around the wetland mitigation areas.

Monitoring: The area will be inspected during monitoring site visits at years one, three, and five. Disturbances will be corrected with planting or other appropriate measures.

Contingency: Evaluate probable causes of disturbance and develop appropriate corrective actions, which may include fencing or other deterrents.

Maintenance Plan

A detailed maintenance schedule will be developed. The plan will specify the frequency at which maintenance workers hand-weed the mitigation site to remove nonnative and invasive plant species. The plan will specify the species to be considered nonnative and invasive and the level of training for the maintenance workers.

Contingency Plans

If the mitigation site does not achieve the stated performance standards, a wetland ecologist will examine the site to determine the probable cause of the failure. If wetland hydrology is not established, possible causes could include insufficient excavation or soils that are too well drained. Possible solutions include creating new wetland areas or re-excavating the site. If the plants die, possible causes could include disease, dehydration, flooding, or lack of nutrients. Possible solutions include replanting with different plant species, replanting with relocation, or temporary irrigation. If invasive plants are found to have greater than 20 percent cover, maintenance crews will remove the invasive plants by hand or with direct application of approved herbicide, such as Rodeo. If the wetland soils are not appropriate, soil amendments could be added to provide a better substrate.

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Monitoring Plan

Monitoring of the created wetlands is necessary to determine if the performance standards have been met. Monitoring should be performed after construction is complete and during the wetlands ten-year establishment period. Monitoring should be performed in years one, two, three, five, seven, and ten. If plant establishment goals are being met after 3 years, the relative change in plant densities from year to year are not expected to vary greatly; therefore, monitoring every other year is appropriate. The monitoring includes survival and percent coverage of wetland and buffer vegetation, sufficiency of wetland hydrology, establishment of wetland soils, and control of invasive plants.

If the performance standards have not been met, contingency measures should be implemented. Contingency measures may include regrading the site, using a clay or geotextile liner to increase water retention in the soil, replanting or relocating plants, planting different species, installing shade structures, performing additional maintenance, adding soil amendments. If invasive plants are found to have an unacceptable percent cover, maintenance may include removing the plants by hand or applying an approved chemical herbicide such as Rodeo.

Annual vegetation monitoring will determine if plant survival and coverage goals are being met. An annual monitoring report will be prepared describing methods and results. The monitoring report will clearly indicate whether the planting sites are in compliance with the performance standards and will also indicate when maintenance replanting or invasive species controls need to be implemented.

Plant Survival Monitoring

Planting areas will be monitored after one full growing season to verify that the contractor has met the 80 percent survival warranty.

In planting areas, representative subsamples will be used to establish plant survival and invasive plant control goals. The subsample areas will be circular areas with a 5-meter radius so that a minimum of 20 percent of the plantings are sampled. Total plant counts will be performed in the subsample areas and the counts will be compared to the planting density on the landscape plan sheets to establish percent survival. The results from the subsample areas will be extrapolated to determine the survival rate for the entire planting area.

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Vegetation Percent Cover Monitoring

Three methods will be used to monitor existing and planted vegetation at the mitigation sites. The canopy coverage method will be used to determine the relative abundance of vegetation less than 1 meter in height. The line intercept method will be used to determine the relative abundance of small trees and shrubs less than 3 meters in height. Canopy coverage will be estimated visually. Plants will be identified to genus and species level if possible.

All three methods involve sampling along a 60-meter or other appropriate length transect. Permanent transects will be used, and sampling will occur at approximately the same times each year in April or May for sample replication. Approximately 1 transect per acre should be established.

The canopy coverage method (**Daubenmire 1959**) uses a series of 0.25-square-meter quadrants placed along a transect. Spacing of these quadrants will be determined in the field according to planting area size. Typically, a quadrant will be placed at 6-meter intervals along a 60-meter tape so that 10 quadrants are placed on each transect; however, shorter intervals or a shorter transect may be used. Canopy cover will be estimated by imaging a vertical projection from the undisturbed canopies to the ground within the quadrant. Plants do not have to be rooted within the quadrant to be measured.

The line-intercept method (**Canfield 1941**) will be used along the same transects, with the investigator staying to the left of the tape to avoid trampling the canopy coverage transect. Each small tree or shrub for which a vertical projection of its canopy intercepts the transect is measured where it first and last intercepts the transect and at its maximum height on the transect.

Tree canopy will be estimated in a 5-meter radius at three locations along the transect (at the middle and two ends) or a densiometer will be used to measure canopy coverage at each location. Tree species will be recorded.

Equipment needed will include a measuring tape (50 meters), a 3-meter shrub measuring stick, 0.25-meter quadrant, a densiometer, and a camera.

Percent cover will be figured for each layer. For the canopy coverage method, each quadrant will be averaged for the entire site to figure overall coverage. To figure percent cover for the shrub layer, the length of each shrub along the tape will be divided by the length of the tape. To figure percent cover for the tree canopy, the average of each estimate for the site will be figured.

To help ensure a representative sample, the entire mitigation site will also be walked during monitoring, and any areas that have a large number of invasives becoming re-established will be noted and invasives will be removed by the maintenance contractor.

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APPENDIX A
Entranco Memorandum
Stream Geomorphology of Cow Creek

TECHNICAL MEMORANDUM: STREAM GEOMORPHOLOGY OF COW CREEK NEAR GENESEE, IDAHO

Fluvial Geomorphological Evaluation

Entranco characterized the geomorphology of Cow Creek at the mitigation site using maps, aerial photographs, field analysis, and anecdotal evidence provided by local residents.

Geological History

The Cow Creek valley lies within a small valley initially created by basalt flows of the Miocene-aged (22 to 5 million years) Columbia River Basalt. Drill cuttings and exposures along Cow Creek reveal that the basalt is overlain by a stiff clay, which is probably lacustrine (lake) in origin and may be considered to belong to the Latah formation. The Latah comprises lacustrine and aeolian (wind-deposited) sediments that lie atop or between the Columbia River basalt flows. Subsequent to the end of the last glacial period (approximately 12,000 years before present), wind-blown glacial sediments covered much of the region to depths reaching many tens of feet. The wind-blown sediments, or loess, cover the Cow Creek mitigation area to depths of about one to three meters.

It appears that this valley contained a stream channel prior to the deposition of the loess. There are exposures along the banks of Cow Creek that are clearly fluvial (stream) deposits that include draped layers and low-angle foresets comprising well-sorted, medium- to fine-grained sand. Such structures are indicative of sediment transported by moving water.

Prior to European settlement, Cow Creek was probably a typical Palouse grassland. The stream was likely a low-gradient, meandering stream carrying mostly suspended sediment loads. Bedload probably consisted primarily of sand. There may have been associated wetlandswith an associated riparian zone that probably consisted of grasses, sedges, and woody shrubs. Because of the relatively erodible loess substrate, the riparian vegetation may have played a significant role in the stabilization of the streambanks. The stream may have been somewhat incised, but probably had a well-defined channel developed within bankfull limits. In the Rosgen (1996) classification, Cow Creek was most likely a C- or an E-type stream, depending upon the degree of incision.

Anecdotal and physical evidence suggests that the stream was channelized in the 1940s. At least two older residents claimed to have observed the original channelization and subsequent dredging of the channel. A photograph in the local hardware store in Genesee was purported to be of the actual original dredging process. The physical attributes of the stream conform with this information. Local residents indicated that the stream was last dredged in about 1972. The channel was initially down-cut significantly in an attempt to accommodate the large spring runoff events. The channel was either excavated through the loess into the clay layer or the stream has eroded into the clay layer. It is more likely that the channel was excavated and subsequently dredged to the elevation that is seen today. The base-flow channel has presumably developed since the last dredging in 1972.

Current Channel Morphology

The project reach was evaluated using the Rosgen (1996) system of river classification. This system relies on eight quantifiable factors of streams to determine relationships that aid in characterizing channel configurations. These elements are: width, depth, sinuosity, discharge, flow velocity, sediment size, sediment distribution, and channel slope. Changes in any one of these elements results in a change in one or more of the others. The Rosgen stream restoration methodology relies on determining these characteristics in a reference reach, then matching those characteristics or changing the stream configuration with a good understanding of the resultant geomorphological changes.

The reach of Cow Creek in the project area presents several major challenges to this methodology. First, no reference reaches could be found locally. Human impacts to the area are deep, resulting in the channelization or rerouting of every stream in the area. Some data are available for such situations in different portions of the country, but those data are scanty and not well documented.

Second, Cow Creek is somewhat unusual in the Palouse region because it occupies a broad, low-sloping valley. Most of the Palouse region is hilly, resulting in comparatively steeply-sloped channel configurations that are structurally controlled.

Third, Cow Creek has been channelized and dredged. This destroys the natural sinuosity, width-depth ratios, incision ratios, etc. Such streams are sometimes not good candidates for "restoration" within the excavated channels.

Last, the geology and hydrology have combined to create a bimodal system. It is difficult to describe this system and determine those features that should be used to develop an appropriate classification. The problem lies in the fact that the Rosgen system is based on bankfull depths. The bankfull characteristics are based on hydrological event recurrence intervals of 1.7 to 2 years. Cow Creek exhibits an extraordinary difference between base flow and bankfull flow. The high end of the base-flow discharge falls into the range of 0.4 to 0.6 cubic meters per second (cms) (15 to 20 cubic feet per second [cfs]), which occurs over nearly the entire year (figure 1). The estimated two-year recurrence flow is 9.7 cms (342 cfs). Annual high flows range from 3.1 to 27 cms (970 cfs) and were recorded at a gage near the project area between October 1, 1979 and September 30, 1986. The highest flows occurred in the months of February and March, and the duration of these high discharge events is commonly only a few days, sometimes as little as a single day. Thus, base flow has created a channel system within the boundaries of the larger cut. This has occurred because The base flow is of much longer duration than the short, high-discharge events, and therefore able to accomplish more work. Since additional long-term discharge measurements are unavailable, and since the wetland mitigation must be stable under the conditions of higher flow, the larger, channelized form was determined to be the appropriate morphological form to characterize.

Field Data

To complete a Level 1 Rosgen classification, the stream must be mapped and certain geomorphological characteristics must be collected. ITD provided the initial base map, which was further refined with field mapping. Data collected for the mapping included the top of the channel bank, toe of the channel bank, location of the base-flow channel, configuration of the bridges at either end of the project area, top of the basalt where exposed in the base-flow channel, top of the clay layer that overlies the basalt, bankfull discharge elevation where visible, and other features deemed important to the stream delineation and the wetlands restoration. These measurements were integrated into a base map of the channel within the project area.

Most mapping elements were readily measured. Bankfull markers, however, were ambiguous in many places because of the extensive erosion occurring within the channel. Bankfull indicators are further obscured by differential erosion that occurs between the loess and the underlying clay layer. The clay is considerably less erodible than the loess and there is a visible change in slope between the two layers that could easily be interpreted as a geomorphic bankfull indicator. In addition, there is virtually no vegetation on the channel bank due to its steepness and instability.

Channel cross-sections were measured in detail at three locations. Flow velocity measurements were also obtained at these locations. Numerous

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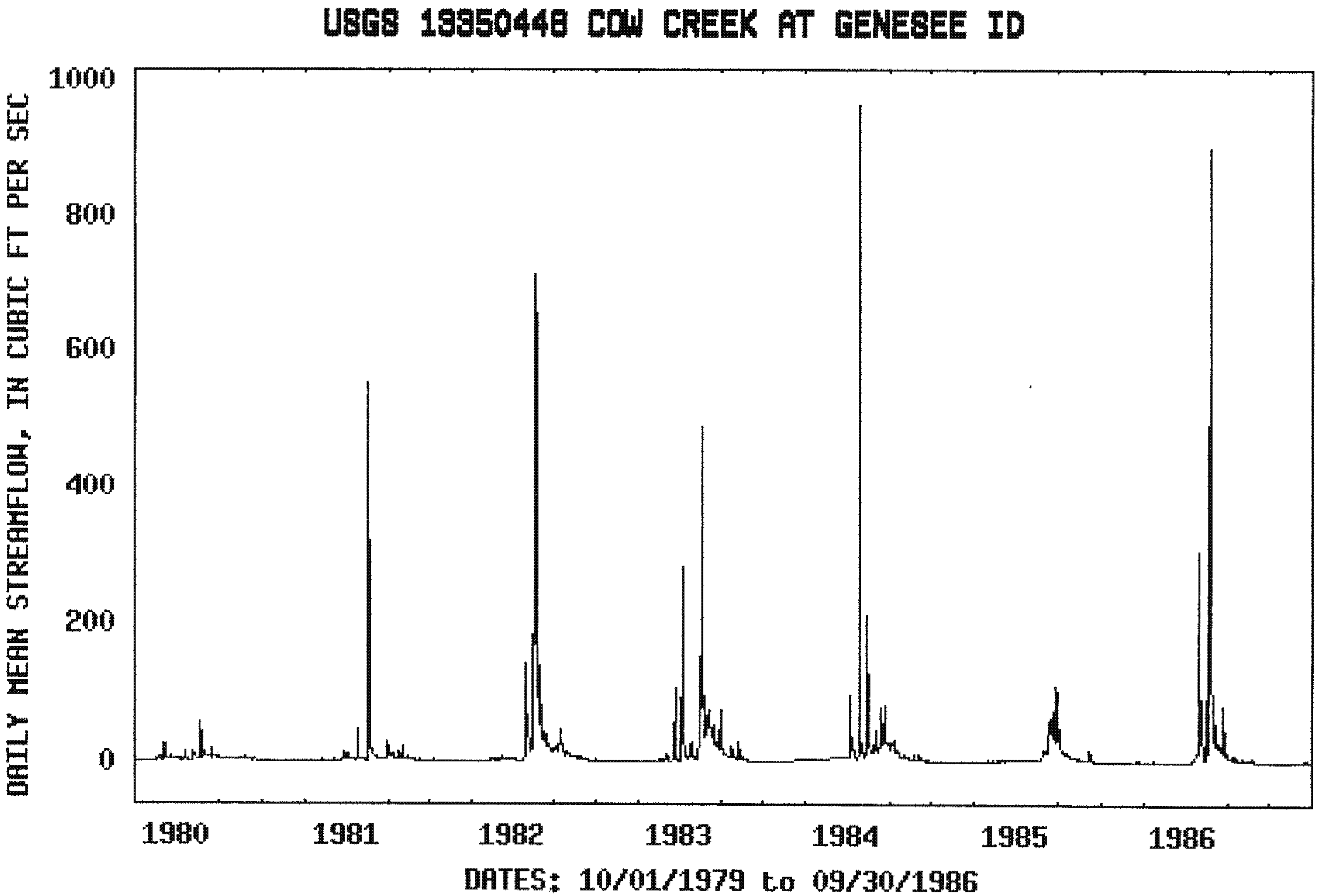

Figure A-1
Hydrograph of Cow Creek from October 1979 – September 1986
from a gage near Genesee, Idaho.

additional cross-sections were surveyed as part of the existing wetlands delineation and subsequent stream channel investigation.

Detailed pebble counts were not undertaken because the channel base consists of silt and clay nearly everywhere. A few areas of coarser material were noted, but none occurred at any of the measured cross-section sites. The coarser material is contained within the base-flow channel and consists of basalt that has been eroded from the underlying bedrock.

Classification

The Rosgen classification process begins with the characterization of the stream valley's incision. The entrenchment ratio is based upon the ratio of the floodprone area to the bankfull channel depth. Floodprone area is defined as 1.5 times the bankfull depth. The entrenchment ratio was calculated for a number of cross-sections and found to be less than 1.4 (table 1).

Table A-1
Basic Geomorphological Characteristics of Cow Creek at Genesee, Idaho.

Cross-section	Entrenchment Ratio	Width-Depth Ratio	Sinuosity	Slope	Channel Material
CCX-4	1.19	9.65	N/A	0.0024	clay and silt
CCX-14	1.13	24.25	N/A	0.0024	clay and silt
CCX-17	1.16	12	N/A	0.0024	clay and silt
CCX-19	1.10	18.5	N/A	0.0024	clay and silt
CCX-23	1.14	18	N/A	0.0024	clay and silt

The width-depth ratio, which is roughly between 10 and 25 (Table A-1), is calculated by dividing the bankfull width by the bankfull depth.

The sinuosity, which is defined as the channel length over the valley length, for the entire reach is 1.08 (Table A-1). This figure, however, is suspect because the stream was channelized. Since it is not a naturally occurring channel and since the original channel course has been obliterated, the sinuosity is a factor that is not of significant value.

The overall slope or gradient of the stream, which is the elevation change over the reach divided by the length of the reach, is 0.0024 (Table A-1). This is based on the bankfull elevations.

The material underlying the channel consists nearly entirely of silt and clay with a veneer of sand and small gravel in a few places. The coarse material

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consists almost entirely of basalt bedrock within the base-flow channel. There are a few small, widely-scattered deposits on the edges of the channel where flow is constricted. These deposits represent small bars consisting of basalt gravel and coarse sand that are probably derived primarily from the bedrock exposed in the bottom of the base-flow channel. The channel carries relatively little bedload with most of the sediment carried as suspended load at the bankfull discharge levels.

The data analysis outlined above indicates that the stream falls into an F6 category, with the caveat that the sinuosity element is questionable. F-type streams generally maintain a sinuosity greater than 1.2. It may be that this stream was more sinuous prior to channelization, however, that is only speculation. No evidence from aerial photographs, or on the ground, suggests the previous characteristics of the stream, so the classification as delineated is the best that can be achieved given the available data.

Streams that have been manipulated by humans commonly respond with adjustments that result in ambiguous geomorphological relationships (Rosgen 1996 and 2001). In the case of Cow Creek, an obvious adjustment is occurring that may be related to the unusually low sinuosity. Lateral erosion of the loess is extant throughout the project area, and this process is typical of streams that are adjusting to a significant change in one or more morphological elements. The lateral erosion of the loess is most likely an "attempt" by the stream to increase sinuosity. Erosion is occurring along the entire channel length, but appears to be the greatest outside of the meanders. This process will eventually yield a more sinuous channel, which, in turn, will further decrease the slope and flow velocity.

Channel Restoration Plan

Introduction

The Cow Creek wetlands mitigation project was not initially intended to be a stream restoration program, but due to the changes in project concepts, the stream channel has become an integral part of the wetlands restoration and creation. Observed wetlands in the Palouse tend to occur next to streams in riparian zones, so the project concept was revised to reflect the regional systems. To accommodate this concept, Cow Creek had to be characterized in its existing state and modeled in the projected configuration. The hydrological and hydraulic modeling are presented in Appendices B and C. Based upon the hydraulic model results, a geometric configuration for the channel was developed that will accommodate both the channel flow and the wetlands. This section deals with the hydraulic conditions that will result from reconfiguring the channel.

To ensure that wetlands are saturated for the appropriate period of time, the channel of Cow Creek will be widened significantly and the bank slopes will be reduced. Groundwater studies indicate that, while groundwater is present year-around, the groundwater elevations fluctuate several feet. The channel/wetland design has been focused to maximize the opportunity for groundwater to be available to the wetlands year-around.

Design Parameters

Cow Creek is clearly experiencing very high rates of bank erosion during bankfull or larger flow events. The scope and timing of this investigation did not allow for a specific study of bank erosion rates, but a simple examination of the current channel conditions reveals that erosion is actively occurring. Near-vertical channel wall, slumps, and a total absence of vegetation on the stream banks are all indicators of high erosion rates. This erosion of the silt-dominated loess results in additional sediment loading in Cow Creek as well as a loss of surface acreage proximal to the stream. Thus, channel reconstruction needs to address stabilizing the stream banks.

The wetlands to be developed at Cow Creek will need to be sustained by surface flooding and groundwater infiltration. The elevations of the wetlands have been developed to accommodate this concept. In the process of doing this, however, the channel of Cow Creek will be significantly widened. The results of the channel reconfiguration must be conscientiously addressed to prevent impacts to existing wetlands and structures. It is very important to bear in mind that much of the discussion regarding the discharge, flood recurrence values, bankfull values, and so on may not have emphasized flood duration. The widening of Cow Creek is based upon a 1.7-year recurrence discharge value that, according to available records, has a duration of a few days at most. There is no evidence or likelihood that flows consisting of many tens of cfm are going to occur over weeks or months. Most of the morphological work accomplished in this channel is accomplished by base flows of 1 to 20 cfs. The base flow is accommodated by the existing base-flow channel, which will not be disturbed by the reconstruction. The streambank protection, in-stream structures, and other elements intended to protect the wetlands and stream stability at Cow Creek are based on very large flows that occur only a few days of the year. The structures will have no impact on the base-flow channel or any part of the system that currently falls within the toe of slope on either side of the channel. By managing the stream in this way, conditions within the existing channel base remain essentially the same.

Stream Channel Management and Streambank Protection

As noted above, changes in any one parameter of a channel's configuration will affect other elements of the stream system. In this case, widening the channel will slow the stream flow. It will also change what is called "base level." That is, at the point where the channel widens, the water will spread out across the channel, and the water surface elevation at bankfull will drop. Thus, there is a change in potential energy from the existing bankfull flow elevation to that within the widened channel. This, in turn, will increase the velocity of the stream at that point with a potential for additional erosion. To mitigate this process, several elements must be addressed.

First, the channel widening must occur some distance downstream of the bridge, not at the downstream wingwalls of the bridge. This leaves enough streambank to protect the bridge. The channel may be hardened to prevent widening at the channel opening. Alternatively, the channel widening may occur gradually from the bridge to its full width over the 20 meters between the bridge and the reconfigured channel. This will still result in increased velocities (Appendix B), which will be managed by removing material beneath the upstream bridge and hardening the channel with riprap. The effect of this will be to increase the channel flow area and lower the channel elevation beneath the bridge to match the upstream and downstream profiles.

Second, the flow through the entire channel must be managed to keep the maximum flow moving down the existing channel width. This element protects the reconstructed wetlands as well as increases flow velocities down the existing channel area. The preferred management technique for this element involves placing cross-vanes. Cross-vanes are structures constructed of logs, coir rolls, or boulders built in a specific manner that will reduce flow velocities near the stream banks, increase flow down the center of the channel, and redirect flow from the banks toward the channel. In the Rosgen methodology (Rosgen, 2001), the cross-vanes are built pointing upstream at an angle between 20 and 30 degrees into the flow. The base, or downstream end, of the structures is placed so that the top of the structure coincides with the bankfull elevation. The structures will have negative grades into the flow of two to seven degrees. A steeper grade on the structure results in lower flow velocities near the bank than would occur with a shallower grade. This slope is also defined in part by the gradient of the stream flow surface at bankfull. Higher velocity streams, for example, may require a higher cross-vane slope to provide the appropriate protection at the stream bank.

The streambanks will be protected in three ways. By lowering the grade of the streambanks and widening the channel, near-bank flow velocity will be lowered relative to the existing conditions. The cross-vanes add an additional element of protection by further reducing flow velocities along the sides of the channels. Last, the entire constructed wetland area will be vegetated, mostly with scrub-shrub or wetland forest species. These species can provide a greater element of protection because, when properly established, they create an higher roughness factor for the channel, which reduces flow velocity. Thus, the center of the existing channel, which will consist predominately of wetland emergents, will have the lowest roughness and no impeding structures. This situation will encourage unimpeded flow down the center of the channel, in much the same fashion as existing conditions allow.

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APPENDIX B
Entranco Memorandum
Cow Creek HEC-RAS Model

TECHNICAL MEMORANDUM: COW CREEK HEC-RAS MODEL

A hydraulic model of Cow Creek and the proposed wetland mitigation was developed to investigate the current flow conditions and to aide with the proposed design. Cow Creek has a very small baseflow but experiences large flows for short periods of time during larger events. The current geometry of the creek consists of a small 2-meter wide by 1-meter deep rectangular channel that carries the baseflow, and lies within the bottom of a larger rectangular channel that is approximately 15 meters wide by 2.5 to 3.5 meters deep. The large channel carries the "flashy" flows of larger runoff events described in the hydrological evaluation (Appendix C of the Mitigation Plan) and, therefore, is the channel of interest in this model. The following paragraphs explain the process of modeling Cow Creek with the software package HEC-RAS.

Before a model could be built, the hydrology of the area had to be analyzed. This work was performed and checked by subconsultants to Idaho Transportation Department and to Entranco. David Evans and Associates performed the original hydrology, and their work was evaluated by Bruce Barker, PE. The letters and calculations from both firms are located in Appendix C. Three different USGS regression equations were used to calculate flows for this basin: USGS Open File Report 81-909 *A Method for Estimating Flood-Frequency Parameters for Streams in Idaho*, USGS Water-Resource Investigation 7-73 *Magnitude and Frequency of floods in Small Drainage Basins in Idaho*, and USGS Open file Report 74-336 *Magnitude and Frequency of Floods in Washington*. The two sets of regression equations developed for the USGS Idaho reports produced very similar discharge values. The discharge values from the Washington report were similar to the others for more frequent events, such as the 5-year storm, but were significantly higher for the larger events. (**Figure B-1**) It was determined that the discharges from USGS OFR 81-909 were the most appropriate to use in the model based upon historical flood data, conversations with landowners in the area, and the recommendation of the two firms that prepared the calculations.

A HEC-RAS model of the existing conditions was developed using survey information and field observations. A 3-D base map was developed using surveyed topography and cross-sections. From this electronic surface, twenty-eight cross-sections were cut at the appropriate hydraulic locations and imported into HEC-RAS (Figures B-2 – B-5). Photographs associated with specific cross-sections were

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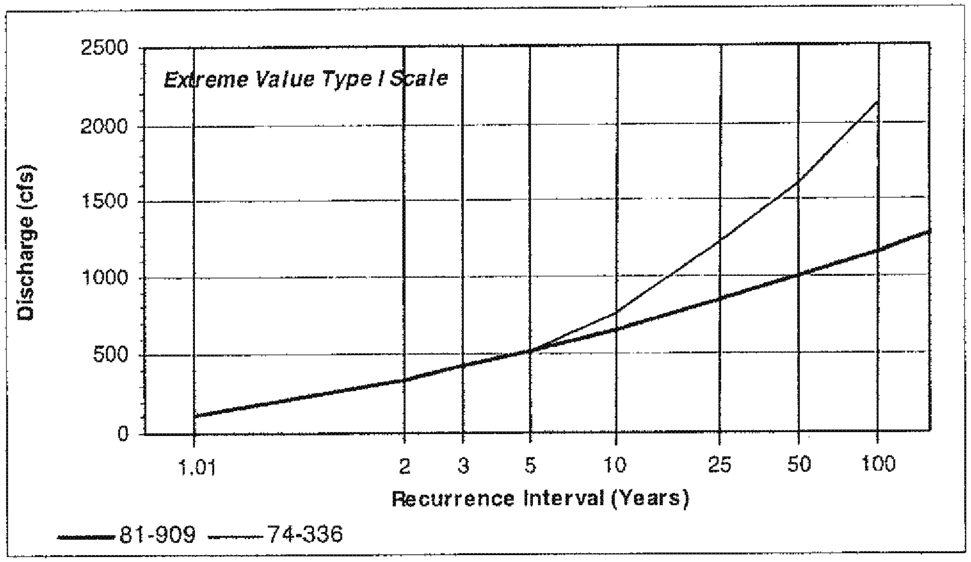

Flood Frequency Estimate Comparison, USGS OFR 81-909 and USGS OFR 74-336, Cow Creek ID at US-95 referenced along with field data to help determine parameters such as roughness coefficients.

Manning's roughness coefficient, "n", was determined from Chow[1], Table 5-6. The bottom of the existing channel was given a value of 0.035 to 0.045, depending on the vegetation and conditions at each cross-section. The right and left overbanks, which consist of the earth slopes and the cultivated fields on top of each bank, were assigned a value between 0.025 and 0.035. The "n" value for a cultivated field and an excavated earth channel are very similar, and therefore one value for both was deemed appropriate.

One bridge is located on each end of the wetland mitigation site. The upstream bridge has a single span of approximately 10 meters. It has concrete abutments with wing walls and steel beam girders. The downstream bridge is also a single span of approximately 6 meters with concrete abutments and wing walls. The geometries of both bridges were measured in the field and entered into HEC-RAS. The downstream bridge had some riprap recently dumped around the abutments and wing walls. Manning's n was adjusted to 0.05 in this area to account for the riprap. The stability of the riprap is questionable since there is a significant amount of fines and small material associated with it.

Few data are available for calibrating the model, so field observations had to be used. In this region of the country, "bankfull" flow typically corresponds to the 1.7-year precipitation event[2]. Geomorphic indicators revealed this bankfull elevation in the walls of the channel at certain locations along the creek. The 1.7-year event of approximately 8.5 cubic meters per second (cms)(300 cubic feet per second (cfs)) was run in the model and the water surface elevations were compared to the bankfull elevations measured in the field. The results showed that the two elevations compared very well, indicating that the model is reasonably accurate.

As an additional check, cross-sections were interpolated using HEC-RAS to investigate the effect they had on the water surface. Cross-sections were first interpolated every 50 meters, which added 11 to the geometry. Cross-sections were then interpolated every 20 meters, which added 45 to the geometry. The model was run after each interpolation and compared to the original model. The water surface elevation changed by less than 0.05 meters for each case. This indicates that the original 28 cross-sections are sufficient for this model.

Once the model of the existing conditions was set, peak discharges from various storm events were run. All discharges up to the 50-year storm are contained within the channel. The 50-year storm is contained by the channel along the entire reach until just before the downstream bridge where it overtops the left bank (facing

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1. Chow, Ven Te. *Open Channel Hydraulics*. McGraw Hill, Boston, MA. 1954.

2. Rosgen, Dave. Stream Geomorphology. *Wildland Hydrology*, Pagosa Springs, Co. 1996; 2002.

downstream). The 100-year storm event is contained within the channel until about 150 meters upstream of the bridge. The constriction of the bridge causes the water to back up and come out of the banks. The 500-year discharge overtops the banks upstream of the bridge, and several other places along the reach. The main channel velocities at bankfull range from 1 to 3 meters per second (m/s) with the highest velocities occurring underneath the bridge. The velocities at the 100-year discharge range from 1 to 6 m/s. The channel velocities for most of the reach are approximately 3 m/s, with an increase in velocity to 6 m/s under the bridge.

On March 20 and 21, 2003, velocity was measured in the field at three locations along Cow Creek The measured velocities ranged from 0.27 to 0.61 m/s. The small base-flow channel was flowing approximately full and a discharge of approximately 0.45 cms was calculated. The roughness coefficients in the model were temporarily adjusted to reflect the bedrock bottom and clay sides of the small channel, and then the model was run with a discharge of 0.45 cms. The velocities at two of the three locations in the model fall within the measured range, again indicating that the model is reasonably accurate. The results of the HEC-RAS run with the existing conditions are attached.

The proposed design of the wetland mitigation consists of reducing the side slopes and widening the larger channel to accommodate the new wetland. The geometry of the existing cross-sections was modified to reflect the proposed design. Additional cross-sections were interpolated by HEC-RAS near the upstream bridge to better model the channel transition. The roughness coefficients were also changed in the model to reflect the proposed conditions. A Manning's *n* value was again selected from Chow, Table 5-6. The wide bottom of the proposed channel will be planted with various types of plants such as emergent wetland, shrubs, and trees. These plants resemble the roughness of a floodplain, and therefore an *n* value of 0.05 was chosen from the description of "Light brush and trees on a floodplain." The center of the channel was left as 0.04, since the proposed wetland plants for this area have approximately the same roughness as the existing grasses.

An initial run of the proposed conditions revealed a drop in the water surface elevation between the two bridges. The new channel configuration produced an M2 (Chow) water surface profile underneath the upstream bridge. This hydraulic drop increased the velocity underneath and downstream of the bridge to levels much higher than the model showed for the existing conditions.

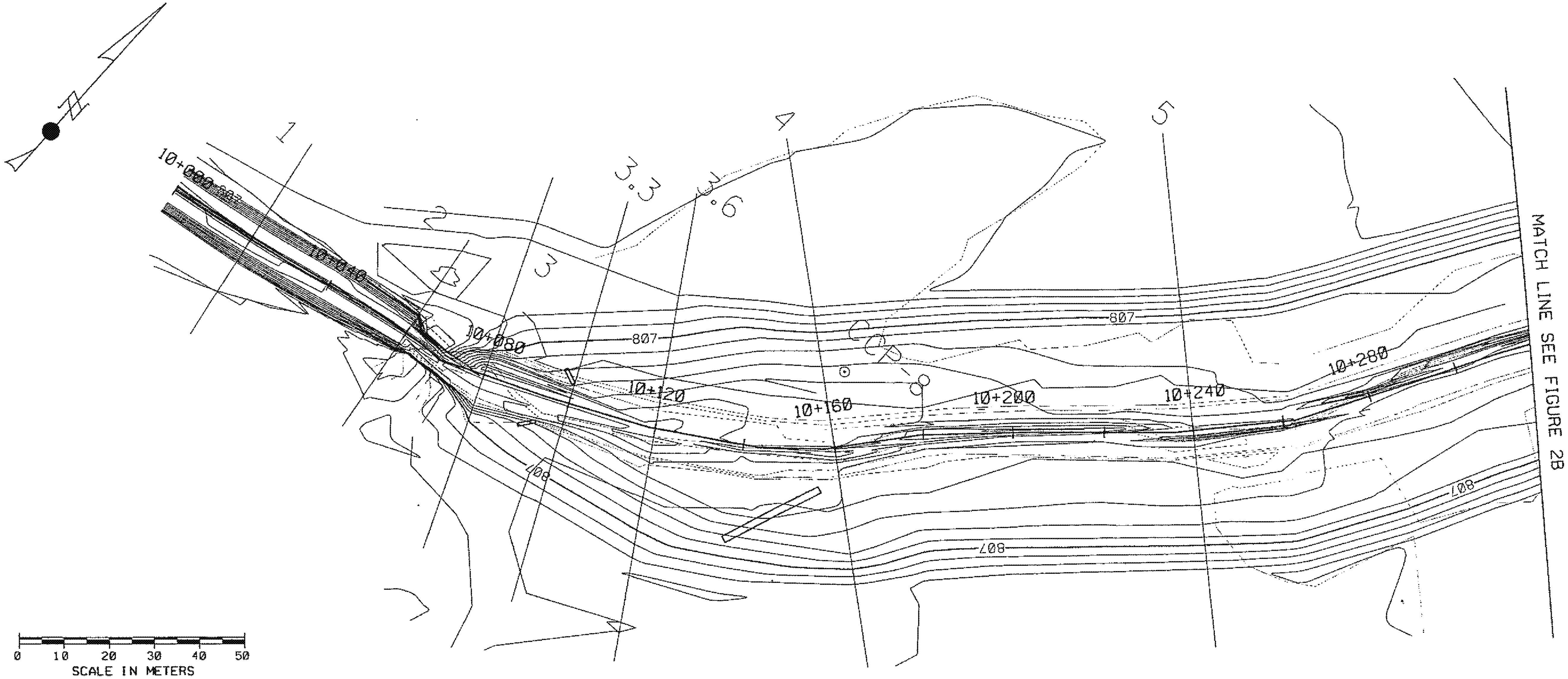
Several changes were proposed to help slow down the velocities at the upstream bridge. The existing flow regime under this bridge is one of deposition, and therefore a high spot in the channel profile has developed. This high spot constricts the flow and increases the velocity. The first proposed measure is to remove this depositional material thereby reducing the constriction. Riprap placed under the bridge and on the abutments will also protect the bridge from scour and reduce velocities. These changes were made in the model. The channel elevation under the bridge was reduced by approximately 0.4 meters, and the roughness coefficient was increased to 0.055 to represent riprap protection.

Another measure to protect the stream bank and reduce the velocity near the upstream bridge was to introduce cross-vane structures into the channel. These flow control structures are proposed in these areas as a means of directing flow toward the area of the currently existing channel. The structures will also serve to protect the plantings until they have a chance to mature.

The vanes were placed along the first meander downstream of the bridge. Three are located on the on the right bank and one on the left. The vanes were entered into the model by moving the ground points to the approximate elevation of the top of the structure at each cross-section. The cross vanes will be placed at an angle in the field, but are modeled as perpendicular to the channel since HEC-RAS is a two-dimensional model and only accounts for flow perpendicular to the cross-section.

After the geometry of the proposed conditions was complete, large storm events were run in the model to investigate the stream's response to the change in channel shape. As mentioned above, the widening of the channel significantly lowered the water surface elevation. For most of the reach, the modeled 100-year storm was well within the banks of the new channel. The one exception was just above the downstream bridge. The model showed the water just overtopping the bank due to the backwater effects of the bridge, which was also shown in the existing conditions. This downstream bridge creates a constriction and causes an M1 (Chow) backwater profile for approximately 450 meters above the bridge. The velocities in the new channel were fairly low even at the 100-year storm, ranging from 0.5 to 2.0 m/s in the center of the channel, with the higher velocities toward the upstream end. The outer parts of the channel saw velocities from 0 to 1 m/s. Underneath the downstream bridge was still an area of high velocity ranging from 2 to 3 m/s in the main channel, which is comparable to the existing conditions. The velocities under the upstream bridge range from 1.75 to 2.5 m/s at the 100-year storm. The measures described above reduced the velocities in this area by approximately 0.4 m/s.

Overall, the response of the model to the proposed changes for both large and small flows appears reasonable. The model of the existing conditions shows the creek out of its banks just above the downstream bridge at flows larger than the 50-year storm. This also happens for the proposed conditions, although overtopping of the bridge does not appear to be a concern in either case. The surrounding terrain is such that the water will flood adjacent fields before overtopping the roadway for both existing and proposed conditions. The results of the HEC-RAS run with the proposed conditions are attached.



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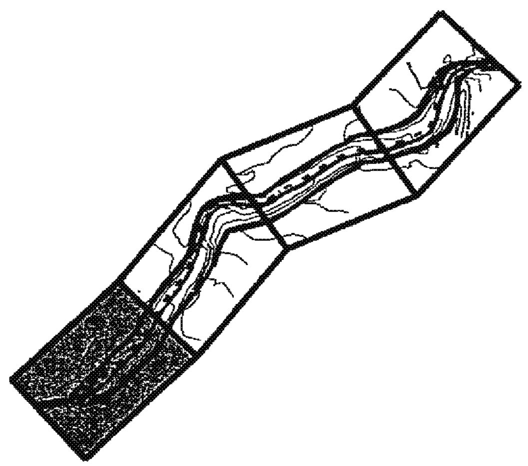

LEGEND

PIEZOMETER NAME AND LOCATION	CCP-8	PROPOSED CONTOURS CONTOUR INTERVAL = 0.25 m	807
HEC-RAS CROSS SECTION (EXISTING AND PROPOSED CONDITIONS)	3		
FIELD CROSS SECTION (EXISTING CONDITIONS)	CCX12	EXISTING CONTOURS CONTOUR INTERVAL = 0.50 m	

entranco

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PRELIMINARY
FOR CONSTRUCTION

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NO.	DATE	BY	DESCRIPTION
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12/19/2003

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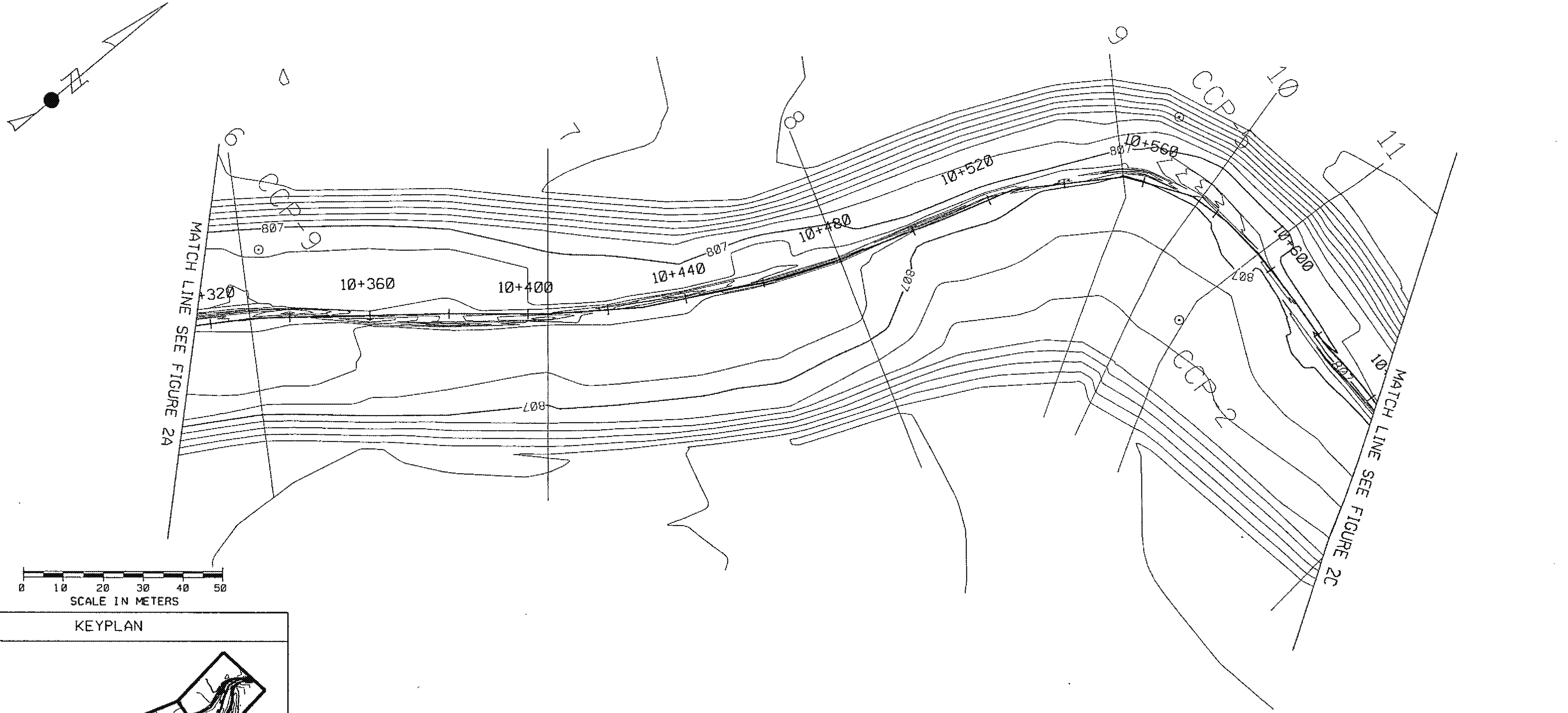
DESIGN CHECKED	
DETAILED	CADD FILE NAME
DRAWING CHECKED	DRAWING DATE:

IDAHO TRANSPORTATION DEPARTMENT

FEDERAL AID PROJECT NO.
NH-4110(133)

WETLAND MITIGATION
US-95
TOP OF LEWISTON HILL TO MOSCOW
GEOMORPHOLOGY TECHNICAL MEMO

metric
COUNTY
LATAH/NEZ PERCE
KEY NUMBER
7769
FIGURE B2



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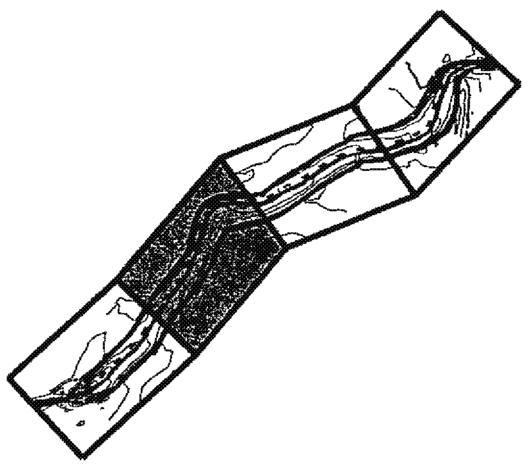

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HEC-RAS CROSS SECTION (EXISTING AND PROPOSED CONDITIONS)	3		
FIELD CROSS SECTION (EXISTING CONDITIONS)	CCX12		EXISTING CONTOURS CONTOUR INTERVAL = 0.50 m

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FOR CONSTRUCTION

REVISIONS										
NO.	DATE	BY	DESCRIPTION	DESIGNED		IDAHO TRANSPORTATION DEPARTMENT	FEDERAL AID PROJECT NO.	WETLAND MITIGATION	metric	
				DESIGN CHECKED			NH-4110(133)	US-95 TOP OF LEWISTON HILL TO MOSCOW GEOMORPHOLOGY TECHNICAL MEMO	COUNTY LATAH/NEZ PERCE	
				DETAILED	CADD FILE NAME				KEY NUMBER 7769	
				DRAWING CHECKED	DRAWING DATE:				FIGURE B3	

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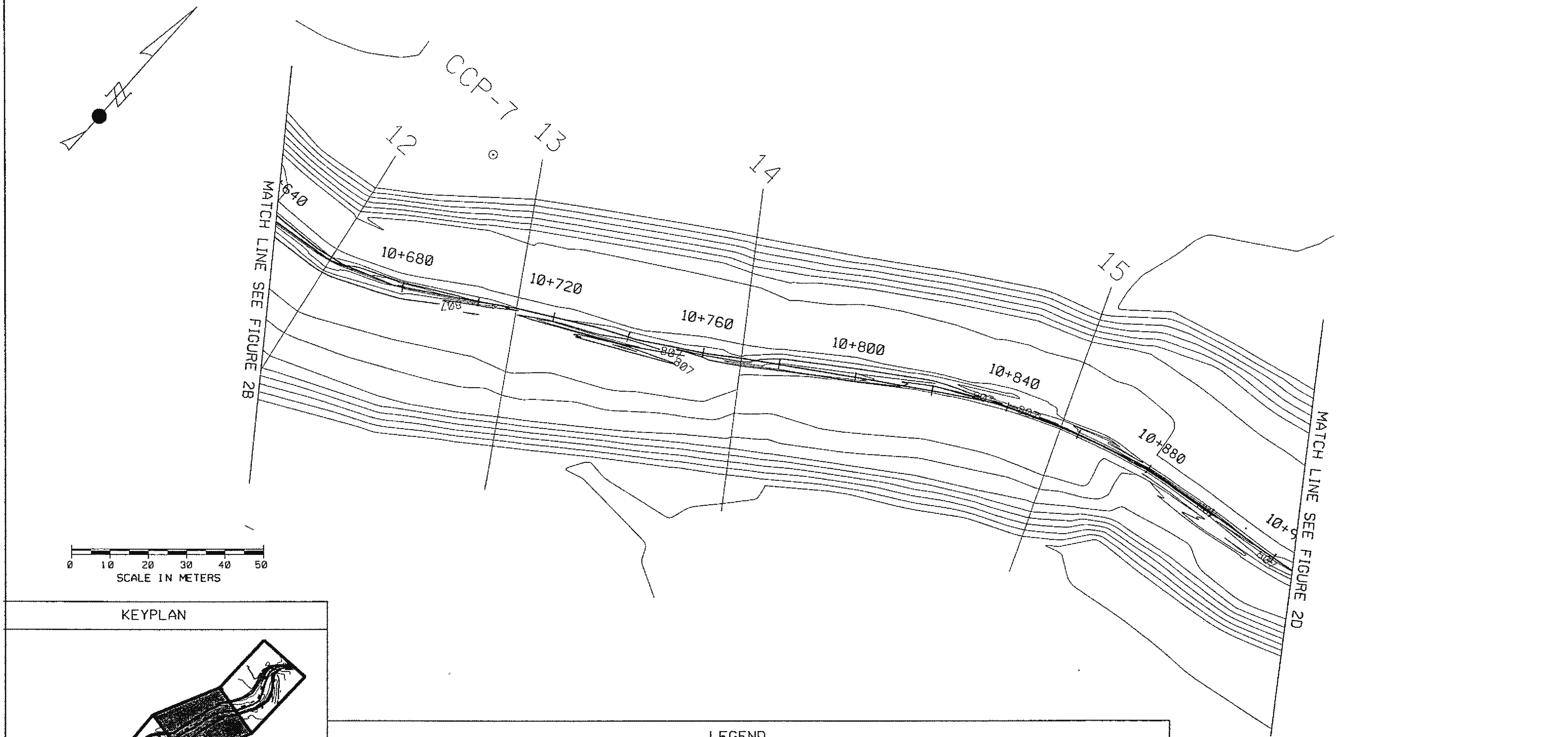

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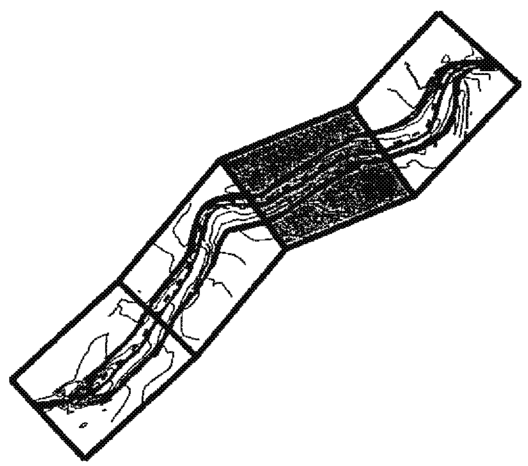

LEGEND

PIEZOMETER NAME AND LOCATION	CCP-8	807	PROPOSED CONTOURS CONTOUR INTERVAL = 0.25 m
HEC-RAS CROSS SECTION (EXISTING AND PROPOSED CONDITIONS)	3		
FIELD CROSS SECTION (EXISTING CONDITIONS)			EXISTING CONTOURS CONTOUR INTERVAL = 0.50 m

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REVISIONS			
NO.	DATE	BY	DESCRIPTION

12/19/2003

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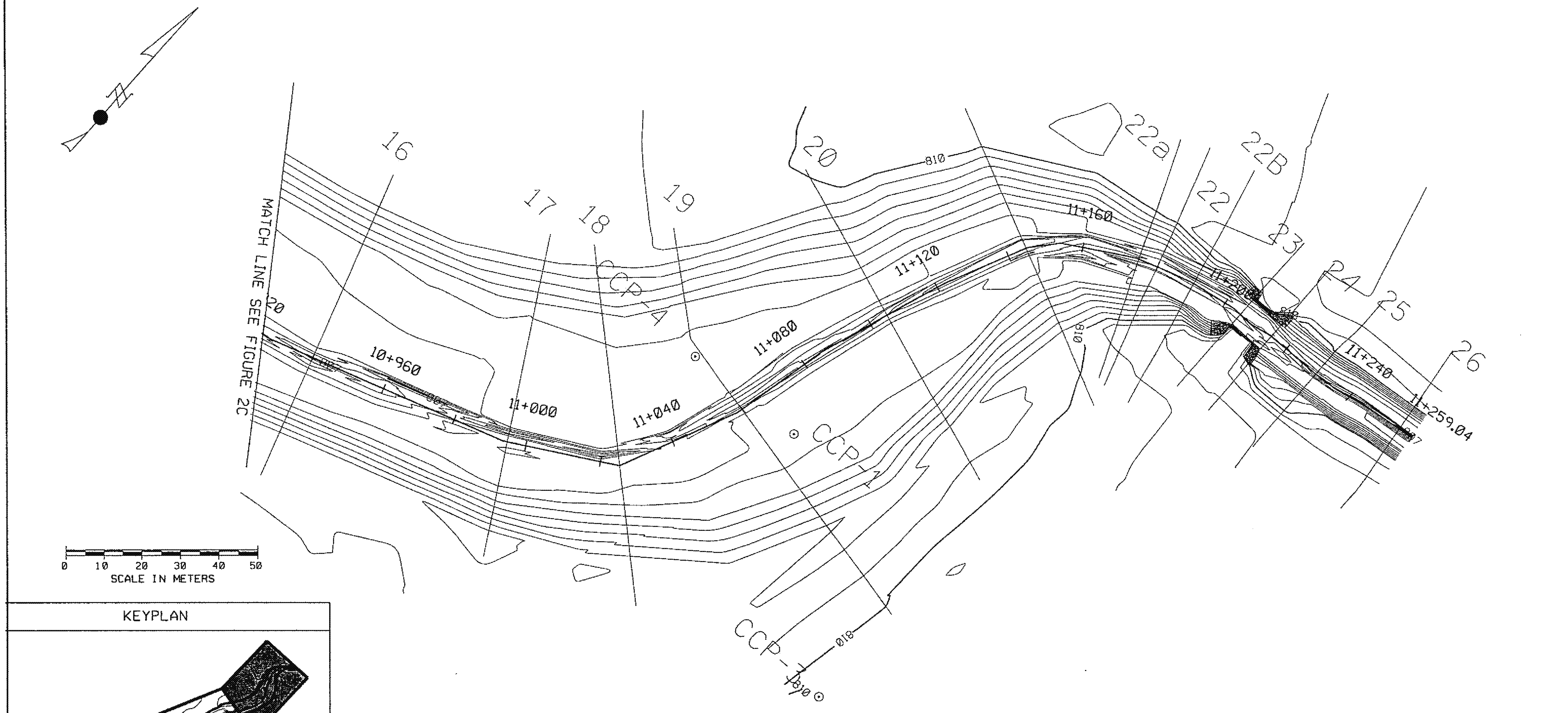
DESIGN CHECKED	
DETAILED	CADD FILE NAME
DRAWING CHECKED	DRAWING DATE:

IDAHO TRANSPORTATION DEPARTMENT

FEDERAL AID PROJECT NO.	WETLAND MITIGATION	metric
NH-4110(133)	US-95 TOP OF LEWISTON HILL TO MOSCOW GEOMORPHOLOGY TECHNICAL MEMO	COUNTY LATAH/NEZ PERCE KEY NUMBER 7769 FIGURE B4



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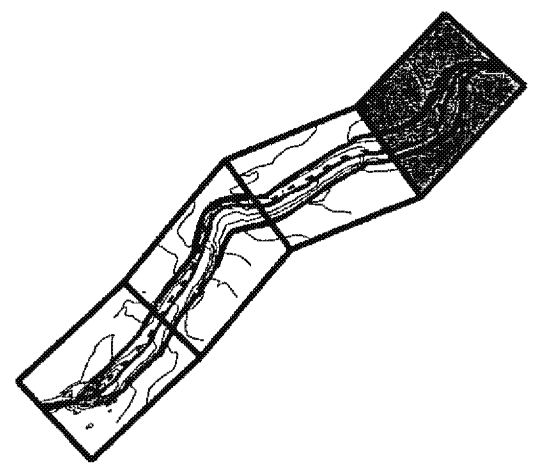

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HEC-RAS CROSS SECTION (EXISTING AND PROPOSED CONDITIONS)	3		
FIELD CROSS SECTION (EXISTING CONDITIONS)	CCX12		EXISTING CONTOURS CONTOUR INTERVAL = 0.50 m

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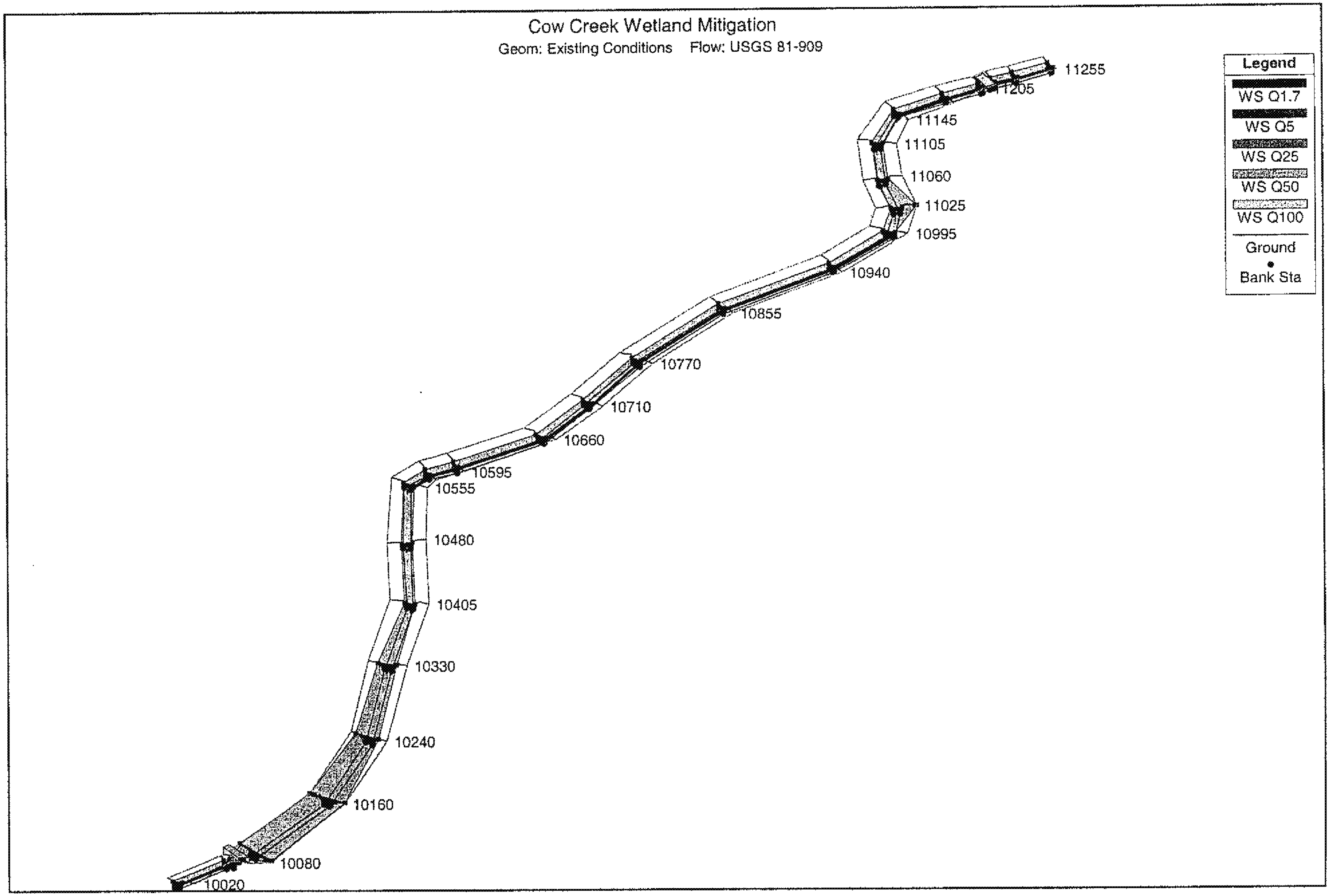
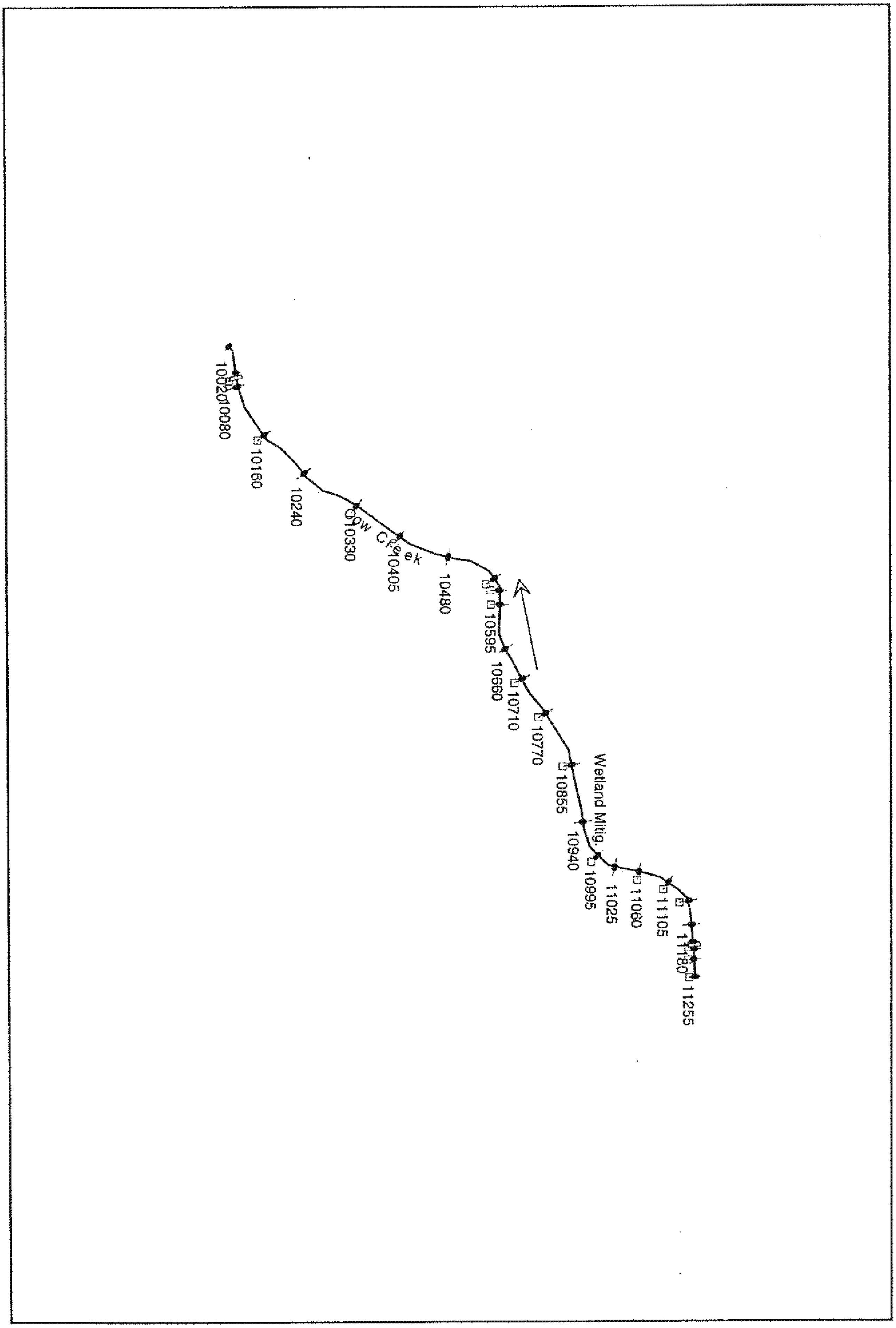
REVISIONS									
NO.	DATE	BY	DESCRIPTION	DESIGNED		IDAHO TRANSPORTATION DEPARTMENT	FEDERAL AID PROJECT NO.	WETLAND MITIGATION	metric
				DESIGN CHECKED			NH-4110(133)	US-95 TOP OF LEWISTON HILL TO MOSCOW GEOMORPHOLOGY TECHNICAL MEMO	COUNTY LATAH/NEZ PERCE
				DETAILED	CADD FILE NAME				KEY NUMBER 7769
				DRAWING CHECKED	DRAWING DATE:				FIGURE B5

12/19/2003


Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
11255
11205
11145
11105
11060
11025
10995
10940
10855
10770
10710
10660
10595
10555
10480
10405
10330
10240
10160
10080
10020
Legend
WS Q1.7
WS Q5
WS Q25
WS Q50
WS Q100
Ground
Bank Sta


10020
10080
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10240
10330
Crow Creek
10405
10480
10595
10660
10710
10770
10855
Wetland Mitig.
10940
10995
11025
11060
11105
11180
11255

HEC-RAS Plan: Ex, 81-909 River: Cow Creek Reach: Wetland Mitig.

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Wetland Mitig.	11255	Q1.7	8.50	806.98	809.07	808.43	809.10	0.001345	0.85	10.37	11.41	0.26
Wetland Mitig.	11255	Q5	14.70	806.98	809.39	808.64	809.45	0.001529	1.07	14.29	12.46	0.29
Wetland Mitig.	11255	Q25	23.79	806.98	809.77	808.90	809.85	0.001650	1.30	19.17	13.61	0.31
Wetland Mitig.	11255	Q50	28.09	806.98	809.92	809.00	810.01	0.001681	1.39	21.28	14.06	0.32
Wetland Mitig.	11255	Q100	32.73	806.98	810.09	809.11	810.19	0.001665	1.46	23.65	14.58	0.32
Wetland Mitig.	11255	Q500	44.91	806.98	810.51	809.35	810.63	0.001641	1.64	32.78	30.06	0.33
Wetland Mitig.	11230	Q1.7	8.50	807.28	809.03		809.07	0.001303	0.89	10.05	11.80	0.26
Wetland Mitig.	11230	Q5	14.70	807.28	809.36		809.41	0.001413	1.10	14.08	12.88	0.29
Wetland Mitig.	11230	Q25	23.79	807.28	809.73		809.81	0.001480	1.30	19.12	14.12	0.30
Wetland Mitig.	11230	Q50	28.09	807.28	809.88		809.97	0.001494	1.38	21.32	14.62	0.31
Wetland Mitig.	11230	Q100	32.73	807.28	810.05		810.15	0.001522	1.47	23.78	15.79	0.32
Wetland Mitig.	11230	Q500	44.91	807.28	810.48		810.59	0.001542	1.67	33.67	31.02	0.33
Wetland Mitig.	11215	Q1.7	8.50	807.61	809.01	808.42	809.05	0.001206	0.88	10.06	11.35	0.27
Wetland Mitig.	11215	Q5	14.70	807.61	809.33	808.63	809.39	0.001372	1.12	13.87	12.41	0.30
Wetland Mitig.	11215	Q25	23.79	807.61	809.70	808.88	809.79	0.001488	1.36	18.64	13.21	0.33
Wetland Mitig.	11215	Q50	28.09	807.61	809.85	808.98	809.95	0.001521	1.45	20.63	13.25	0.33
Wetland Mitig.	11215	Q100	32.73	807.61	810.02	809.08	810.12	0.001520	1.53	22.80	13.29	0.34
Wetland Mitig.	11215	Q500	44.91	807.61	810.43	809.33	810.56	0.001532	1.73	28.30	14.50	0.35
Wetland Mitig.	11208		Bridge									
Wetland Mitig.	11205	Q1.7	8.50	807.61	809.00		809.04	0.001168	0.87	10.05	10.56	0.27
Wetland Mitig.	11205	Q5	14.70	807.61	809.31		809.37	0.001412	1.14	13.37	10.68	0.31
Wetland Mitig.	11205	Q25	23.79	807.61	809.66		809.76	0.001676	1.44	17.14	10.82	0.35
Wetland Mitig.	11205	Q50	28.09	807.61	809.80		809.92	0.001782	1.57	18.66	10.88	0.37
Wetland Mitig.	11205	Q100	32.73	807.61	809.94		810.08	0.001889	1.69	20.17	10.94	0.38
Wetland Mitig.	11205	Q500	44.91	807.61	810.27		810.46	0.002096	1.97	23.84	11.08	0.41
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Wetland Mitig.	11180	Q5	14.70	807.79	809.23		809.32	0.002997	1.36	11.10	12.04	0.43
Wetland Mitig.	11180	Q25	23.79	807.79	809.59		809.71	0.002767	1.59	15.53	12.95	0.43
Wetland Mitig.	11180	Q50	28.09	807.79	809.73		809.87	0.002708	1.68	17.43	13.32	0.43
Wetland Mitig.	11180	Q100	32.73	807.79	809.87		810.02	0.002661	1.77	19.37	13.67	0.43
Wetland Mitig.	11180	Q500	44.91	807.79	810.22		810.40	0.002568	1.97	24.82	27.94	0.44
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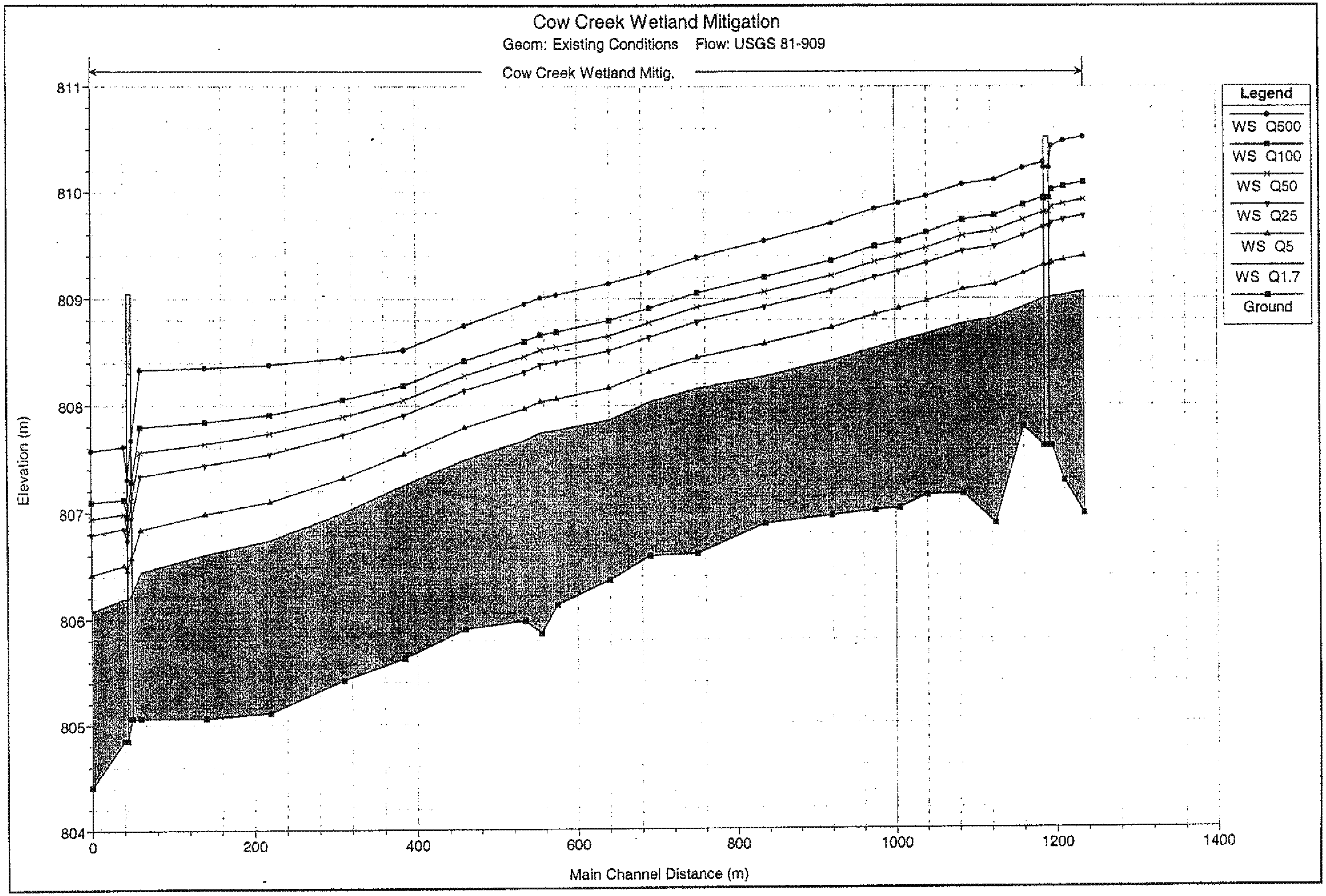
Wetland Mitig.	11145	Q5	14.70	806.89	809.13		809.22	0.002542	1.38	11.15	11.71	0.41
Wetland Mitig.	11145	Q25	23.79	806.89	809.49		809.62	0.002484	1.64	15.52	12.80	0.43
Wetland Mitig.	11145	Q50	28.09	806.89	809.63		809.77	0.002473	1.74	17.39	13.22	0.43
Wetland Mitig.	11145	Q100	32.73	806.89	809.77		809.93	0.002466	1.84	19.31	13.64	0.44
Wetland Mitig.	11145	Q500	44.91	806.89	810.11		810.31	0.002514	2.08	24.78	24.93	0.46
Wetland Mitig.	11105	Q1.7	8.50	807.16	808.77		808.80	0.001193	0.84	10.40	11.57	0.26
Wetland Mitig.	11105	Q5	14.70	807.16	809.08		809.14	0.001358	1.07	14.22	12.43	0.29
Wetland Mitig.	11105	Q25	23.79	807.16	809.44		809.52	0.001511	1.32	18.83	13.41	0.32
Wetland Mitig.	11105	Q50	28.09	807.16	809.59		809.68	0.001561	1.41	20.80	13.81	0.33
Wetland Mitig.	11105	Q100	32.73	807.16	809.73		809.84	0.001606	1.51	22.82	14.21	0.34
Wetland Mitig.	11105	Q500	44.91	807.16	810.07		810.21	0.001755	1.75	29.02	30.75	0.36
Wetland Mitig.	11060	Q1.7	8.50	807.15	808.67		808.72	0.002883	1.01	8.56	11.17	0.35
Wetland Mitig.	11060	Q5	14.70	807.15	808.98		809.05	0.002890	1.24	12.17	12.35	0.36
Wetland Mitig.	11060	Q25	23.79	807.15	809.33		809.43	0.002848	1.48	16.72	13.46	0.38
Wetland Mitig.	11060	Q50	28.09	807.15	809.47		809.59	0.002826	1.55	18.67	13.84	0.38
Wetland Mitig.	11060	Q100	32.73	807.15	809.61		809.74	0.002806	1.63	20.68	14.22	0.39
Wetland Mitig.	11060	Q500	44.91	807.15	809.95		810.11	0.002735	1.80	25.74	17.25	0.39
Wetland Mitig.	11025	Q1.7	8.50	807.03	808.60		808.64	0.001701	0.85	10.45	12.41	0.27
Wetland Mitig.	11025	Q5	14.70	807.03	808.91		808.96	0.001947	1.08	14.36	13.26	0.30
Wetland Mitig.	11025	Q25	23.79	807.03	809.25		809.34	0.002155	1.33	19.09	14.00	0.33
Wetland Mitig.	11025	Q50	28.09	807.03	809.40		809.49	0.002224	1.43	21.10	14.28	0.34
Wetland Mitig.	11025	Q100	32.73	807.03	809.54		809.65	0.002282	1.52	23.21	16.80	0.35
Wetland Mitig.	11025	Q500	44.91	807.03	809.89		810.01	0.002210	1.68	30.48	24.27	0.35
Wetland Mitig.	10995	Q1.7	8.50	807.01	808.54		808.58	0.002494	0.89	9.60	14.04	0.32
Wetland Mitig.	10995	Q5	14.70	807.01	808.85		808.90	0.002164	1.03	14.11	15.11	0.31
Wetland Mitig.	10995	Q25	23.79	807.01	809.20		809.28	0.001977	1.19	19.52	15.69	0.31

HEC-RAS Plan: Ex, 81-909 River: Cow Creek Reach: Wetland Mitig. (Continued)

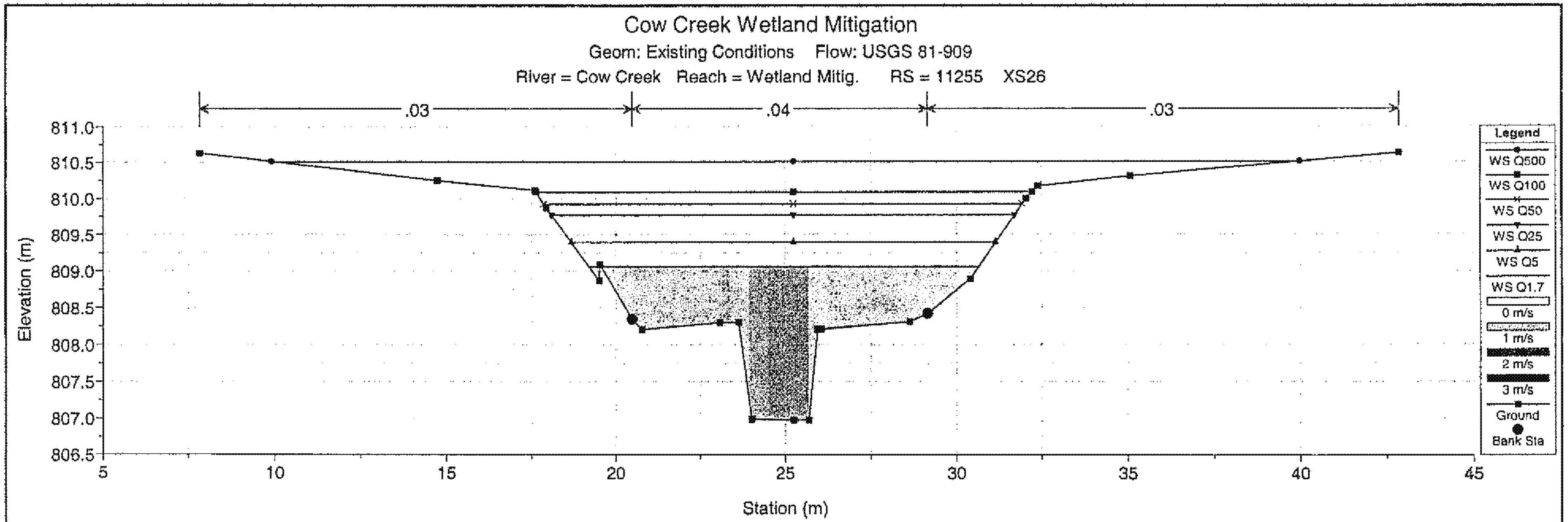
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Wetland Mitig.	10995	Q50	28.09	807.01	809.34		809.43	0.001939	1.25	21.80	16.01	0.32
Wetland Mitig.	10995	Q100	32.73	807.01	809.49		809.58	0.001908	1.31	24.12	16.34	0.32
Wetland Mitig.	10995	Q500	44.91	807.01	809.84		809.95	0.001809	1.45	29.98	17.13	0.32
Wetland Mitig.	10940	Q1.7	8.50	806.96	808.42		808.46	0.001805	0.95	9.13	11.55	0.32
Wetland Mitig.	10940	Q5	14.70	806.96	808.72		808.79	0.001857	1.17	12.85	12.54	0.34
Wetland Mitig.	10940	Q25	23.79	806.96	809.07		809.17	0.001904	1.40	17.33	13.32	0.36
Wetland Mitig.	10940	Q50	28.09	806.96	809.21		809.32	0.001924	1.49	19.23	13.64	0.37
Wetland Mitig.	10940	Q100	32.73	806.96	809.35		809.47	0.001940	1.58	21.16	13.95	0.37
Wetland Mitig.	10940	Q500	44.91	806.96	809.70		809.85	0.001909	1.76	26.15	16.63	0.38
Wetland Mitig.	10855	Q1.7	8.50	806.89	808.27		808.31	0.001667	0.89	9.55	12.25	0.30
Wetland Mitig.	10855	Q5	14.70	806.89	808.58		808.64	0.001692	1.10	13.45	13.18	0.32
Wetland Mitig.	10855	Q25	23.79	806.89	808.92		809.01	0.001733	1.31	18.15	14.09	0.34
Wetland Mitig.	10855	Q50	28.09	806.89	809.06		809.16	0.001748	1.39	20.15	14.45	0.34
Wetland Mitig.	10855	Q100	32.73	806.89	809.20		809.31	0.001758	1.47	22.20	14.82	0.35
Wetland Mitig.	10855	Q500	44.91	806.89	809.54		809.68	0.001910	1.72	27.68	27.05	0.37
Wetland Mitig.	10770	Q1.7	8.50	806.61	808.16		808.19	0.001235	0.82	10.52	11.96	0.26
Wetland Mitig.	10770	Q5	14.70	806.61	808.45		808.50	0.001454	1.06	14.16	12.78	0.30
Wetland Mitig.	10770	Q25	23.79	806.61	808.78		808.87	0.001635	1.31	18.54	13.51	0.33
Wetland Mitig.	10770	Q50	28.09	806.61	808.92		809.02	0.001694	1.41	20.40	13.81	0.34
Wetland Mitig.	10770	Q100	32.73	806.61	809.05		809.17	0.001742	1.50	22.31	14.11	0.35
Wetland Mitig.	10770	Q500	44.91	806.61	809.38		809.53	0.001816	1.71	27.29	22.51	0.37
Wetland Mitig.	10710	Q1.7	8.50	806.59	808.03		808.08	0.002565	1.01	8.33	12.39	0.36
Wetland Mitig.	10710	Q5	14.70	806.59	808.31		808.39	0.002434	1.21	11.97	13.28	0.37
Wetland Mitig.	10710	Q25	23.79	806.59	808.64		808.75	0.002346	1.41	16.44	14.11	0.38
Wetland Mitig.	10710	Q50	28.09	806.59	808.77		808.89	0.002316	1.49	18.36	14.46	0.38
Wetland Mitig.	10710	Q100	32.73	806.59	808.91		809.04	0.002282	1.57	20.36	14.80	0.39
Wetland Mitig.	10710	Q500	44.91	806.59	809.24		809.40	0.002158	1.72	25.44	15.64	0.39
Wetland Mitig.	10660	Q1.7	8.50	806.36	807.86		807.93	0.003669	1.19	7.33	11.50	0.42
Wetland Mitig.	10660	Q5	14.70	806.36	808.16		808.25	0.003107	1.35	11.09	13.28	0.41
Wetland Mitig.	10660	Q25	23.79	806.36	808.51		808.62	0.002616	1.49	16.04	14.82	0.40
Wetland Mitig.	10660	Q50	28.09	806.36	808.65		808.78	0.002470	1.54	18.19	15.30	0.39
Wetland Mitig.	10660	Q100	32.73	806.36	808.80		808.93	0.002350	1.59	20.40	15.77	0.39
Wetland Mitig.	10660	Q500	44.91	806.36	809.14		809.30	0.002143	1.72	26.11	17.98	0.38
Wetland Mitig.	10595	Q1.7	8.50	806.13	807.76		807.79	0.001142	0.81	10.62	11.92	0.25
Wetland Mitig.	10595	Q5	14.70	806.13	808.06		808.11	0.001341	1.04	14.30	12.67	0.29
Wetland Mitig.	10595	Q25	23.79	806.13	808.41		808.49	0.001483	1.28	18.84	13.45	0.31
Wetland Mitig.	10595	Q50	28.09	806.13	808.55		808.64	0.001528	1.37	20.77	13.77	0.32
Wetland Mitig.	10595	Q100	32.73	806.13	808.69		808.80	0.001566	1.45	22.74	14.09	0.33
Wetland Mitig.	10595	Q500	44.91	806.13	809.04		809.17	0.001598	1.64	27.75	14.87	0.34
Wetland Mitig.	10575	Q1.7	8.50	805.86	807.74		807.77	0.001183	0.80	10.92	12.62	0.25
Wetland Mitig.	10575	Q5	14.70	805.86	808.03		808.09	0.001392	1.03	14.76	13.40	0.29
Wetland Mitig.	10575	Q25	23.79	805.86	808.38		808.46	0.001535	1.27	19.52	14.14	0.31
Wetland Mitig.	10575	Q50	28.09	805.86	808.52		808.61	0.001580	1.36	21.54	14.43	0.32
Wetland Mitig.	10575	Q100	32.73	805.86	808.66		808.76	0.001622	1.44	23.60	14.73	0.33
Wetland Mitig.	10575	Q500	44.91	805.86	809.01		809.14	0.001663	1.63	28.83	15.54	0.34
Wetland Mitig.	10555	Q1.7	8.50	805.98	807.67		807.73	0.003606	1.11	7.97	13.40	0.41
Wetland Mitig.	10555	Q5	14.70	805.98	807.97		808.04	0.003047	1.28	12.07	14.24	0.40
Wetland Mitig.	10555	Q25	23.79	805.98	808.32		808.42	0.002680	1.46	17.24	15.26	0.40
Wetland Mitig.	10555	Q50	28.09	805.98	808.46		808.57	0.002584	1.53	19.45	15.68	0.40
Wetland Mitig.	10555	Q100	32.73	805.98	808.60		808.72	0.002507	1.60	21.73	16.09	0.40
Wetland Mitig.	10555	Q500	44.91	805.98	808.95		809.09	0.002479	1.81	28.25	21.78	0.41
Wetland Mitig.	10480	Q1.7	8.50	805.90	807.49		807.53	0.001929	0.94	9.35	11.85	0.32
Wetland Mitig.	10480	Q5	14.70	805.90	807.79		807.86	0.002058	1.18	13.00	12.55	0.35
Wetland Mitig.	10480	Q25	23.79	805.90	808.14		808.24	0.002134	1.43	17.56	13.36	0.37
Wetland Mitig.	10480	Q50	28.09	805.90	808.28		808.39	0.002168	1.53	19.48	13.69	0.38
Wetland Mitig.	10480	Q100	32.73	805.90	808.42		808.55	0.002208	1.63	21.41	14.01	0.39
Wetland Mitig.	10480	Q500	44.91	805.90	808.75		808.91	0.002332	1.87	26.33	17.02	0.41
Wetland Mitig.	10405	Q1.7	8.50	805.63	807.25		807.33	0.003989	1.25	7.09	10.87	0.44

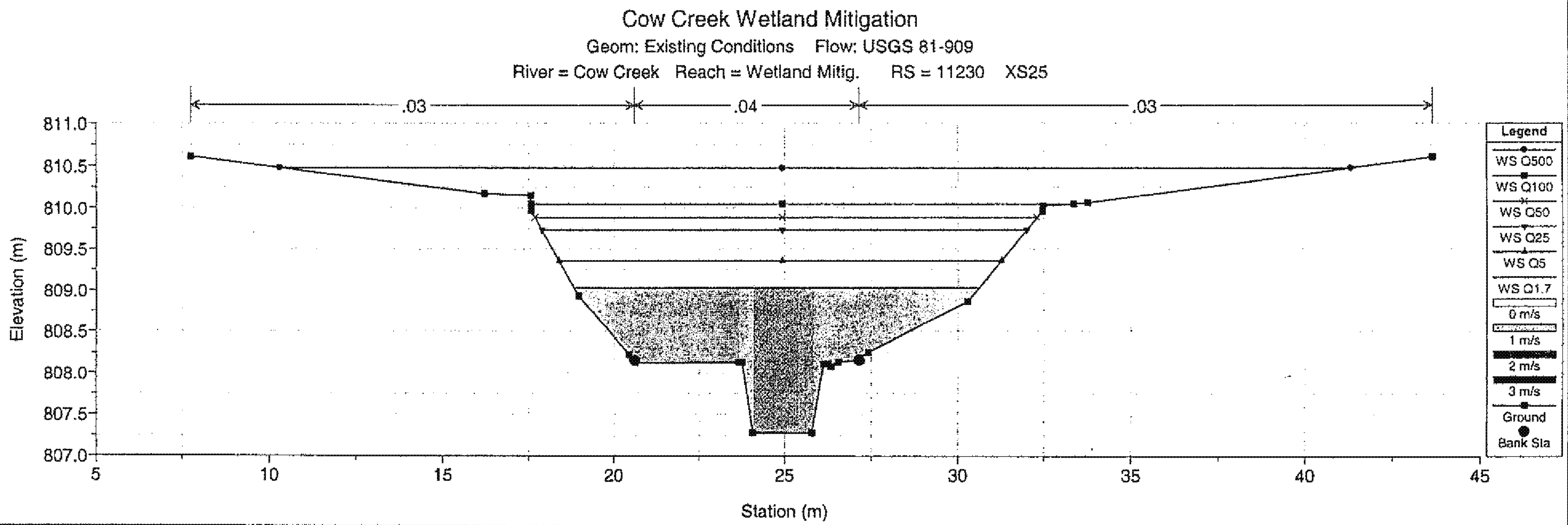
HEC-RAS Plan: Ex, 81-909 River: Cow Creek Reach: Wetland Mitig. (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Wetland Mitig.	10405	Q5	14.70	805.63	807.54		807.65	0.003725	1.48	10.47	12.06	0.45
Wetland Mitig.	10405	Q25	23.79	805.63	807.91		808.04	0.003284	1.68	15.03	13.13	0.44
Wetland Mitig.	10405	Q50	28.09	805.63	808.05		808.19	0.003198	1.77	16.94	13.55	0.44
Wetland Mitig.	10405	Q100	32.73	805.63	808.19		808.35	0.003155	1.85	18.85	13.96	0.45
Wetland Mitig.	10405	Q500	44.91	805.63	808.52		808.71	0.003037	2.04	23.69	15.11	0.45
Wetland Mitig.	10330	Q1.7	8.50	805.42	807.00		807.06	0.003124	1.11	7.85	11.09	0.39
Wetland Mitig.	10330	Q5	14.70	805.42	807.31		807.40	0.002874	1.32	11.53	12.25	0.39
Wetland Mitig.	10330	Q25	23.79	805.42	807.72		807.82	0.002400	1.48	17.93	19.30	0.38
Wetland Mitig.	10330	Q50	28.09	805.42	807.89		807.99	0.002110	1.48	21.45	22.16	0.36
Wetland Mitig.	10330	Q100	32.73	805.42	808.05		808.15	0.001874	1.49	25.30	24.96	0.35
Wetland Mitig.	10330	Q500	44.91	805.42	808.45		808.53	0.001430	1.47	40.21	50.04	0.31
Wetland Mitig.	10240	Q1.7	8.50	805.11	806.74		806.80	0.002701	1.06	8.22	11.45	0.36
Wetland Mitig.	10240	Q5	14.70	805.11	807.10		807.17	0.002206	1.22	12.45	12.43	0.36
Wetland Mitig.	10240	Q25	23.79	805.11	807.54		807.63	0.001817	1.37	19.20	19.01	0.35
Wetland Mitig.	10240	Q50	28.09	805.11	807.74		807.82	0.001573	1.38	23.22	22.72	0.33
Wetland Mitig.	10240	Q100	32.73	805.11	807.91		808.00	0.001501	1.43	27.74	32.22	0.33
Wetland Mitig.	10240	Q500	44.91	805.11	808.38		808.43	0.000728	1.15	50.40	50.00	0.24
Wetland Mitig.	10160	Q1.7	8.50	805.06	806.61		806.65	0.001271	0.88	10.05	11.86	0.27
Wetland Mitig.	10160	Q5	14.70	805.06	806.98		807.04	0.001197	1.05	14.70	13.12	0.28
Wetland Mitig.	10160	Q25	23.79	805.06	807.44		807.51	0.001174	1.25	22.10	21.67	0.29
Wetland Mitig.	10160	Q50	28.09	805.06	807.64		807.71	0.001152	1.32	27.48	37.35	0.29
Wetland Mitig.	10160	Q100	32.73	805.06	807.84		807.90	0.000867	1.22	35.70	44.53	0.26
Wetland Mitig.	10160	Q500	44.91	805.06	808.35		808.38	0.000392	0.94	61.23	50.00	0.16
Wetland Mitig.	10080	Q1.7	8.50	805.06	806.45	806.09	806.50	0.002734	1.07	8.15	11.35	0.38
Wetland Mitig.	10080	Q5	14.70	805.06	806.84	806.28	806.91	0.002014	1.20	12.92	13.85	0.35
Wetland Mitig.	10080	Q25	23.79	805.06	807.33	806.50	807.40	0.001410	1.26	22.10	28.56	0.31
Wetland Mitig.	10080	Q50	28.09	805.06	807.56	806.59	807.62	0.001028	1.17	30.95	43.11	0.27
Wetland Mitig.	10080	Q100	32.73	805.06	807.79	806.70	807.83	0.000633	0.99	44.14	58.06	0.21
Wetland Mitig.	10080	Q500	44.91	805.06	808.34	806.97	808.35	0.000253	0.73	75.50	58.06	0.14
Wetland Mitig.	10067		Bridge									
Wetland Mitig.	10060	Q1.7	8.50	804.85	806.19		806.34	0.006365	1.72	5.39	6.97	0.57
Wetland Mitig.	10060	Q5	14.70	804.85	806.51		806.72	0.006751	2.15	7.71	7.62	0.61
Wetland Mitig.	10060	Q25	23.79	804.85	806.85		807.17	0.007237	2.62	10.57	8.71	0.66
Wetland Mitig.	10060	Q50	28.09	804.85	806.99		807.34	0.007451	2.80	11.77	8.99	0.68
Wetland Mitig.	10060	Q100	32.73	804.85	807.12		807.52	0.007682	2.99	12.98	9.26	0.70
Wetland Mitig.	10060	Q500	44.91	804.85	807.61		808.00	0.005758	3.03	18.89	15.26	0.63
Wetland Mitig.	10020	Q1.7	8.50	804.41	806.08	805.65	806.15	0.003000	1.20	7.34	8.89	0.39
Wetland Mitig.	10020	Q5	14.70	804.41	806.41	805.88	806.52	0.003001	1.46	10.53	9.94	0.41
Wetland Mitig.	10020	Q25	23.79	804.41	806.80	806.16	806.94	0.003000	1.73	14.54	11.11	0.42
Wetland Mitig.	10020	Q50	28.09	804.41	806.95	806.28	807.10	0.003001	1.83	16.26	11.56	0.43
Wetland Mitig.	10020	Q100	32.73	804.41	807.10	806.39	807.27	0.003000	1.93	18.03	11.99	0.43
Wetland Mitig.	10020	Q500	44.91	804.41	807.57	806.66	807.79	0.003004	2.22	25.75	34.74	0.45

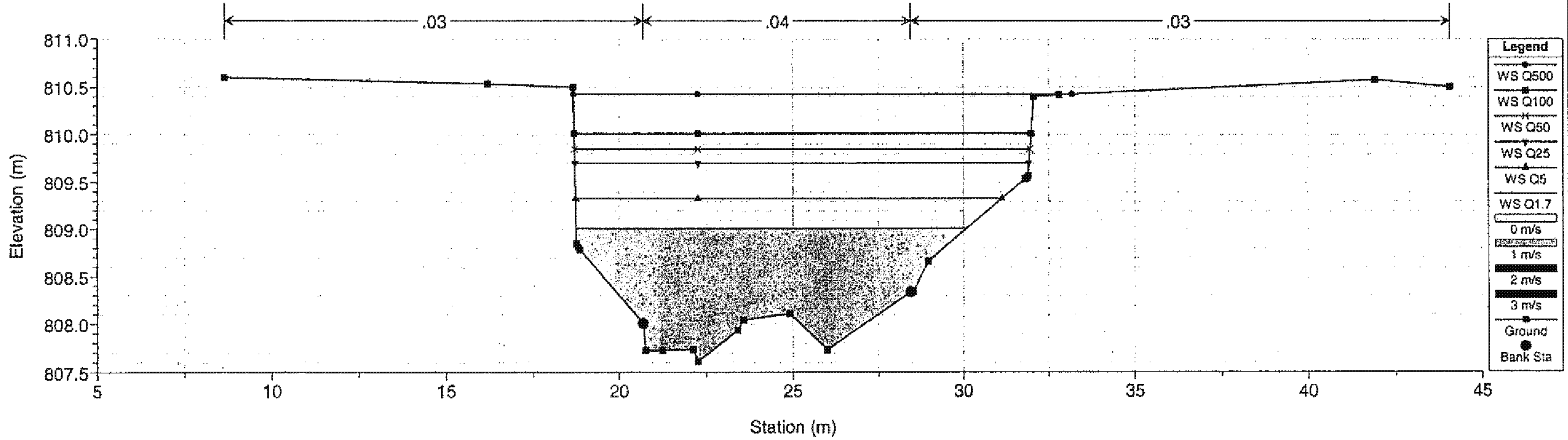


Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
Cow Creek Wetland Mitig.
Elevation (m)
811
810
809
808
807
806
805
804
0
200
400
600
800
1000
1200
1400
Main Channel Distance (m)
Legend
WS Q500
WS Q100
WS Q50
WS Q25
WS Q5
WS Q1.7
Ground

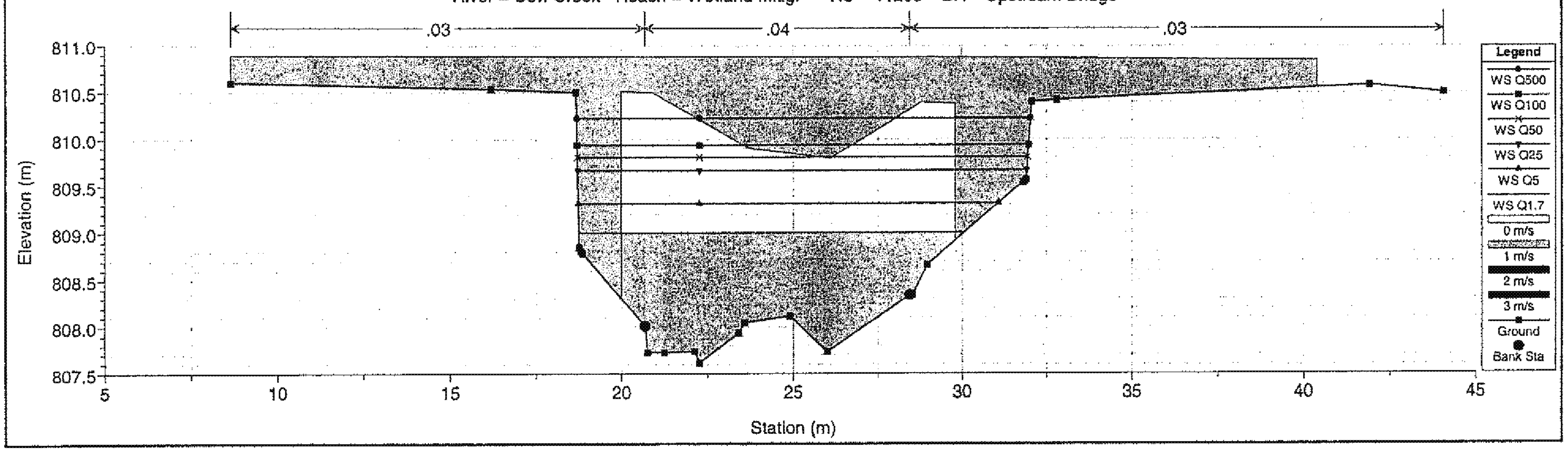

Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11255 XS26
.03
.04
.03
Elevation (m)
Station (m)
Legend
WS Q500
WS Q100
WS Q50
WS Q25
WS Q5
WS Q1.7
0 m/s
1 m/s
2 m/s
3 m/s
Ground
Bank Sta

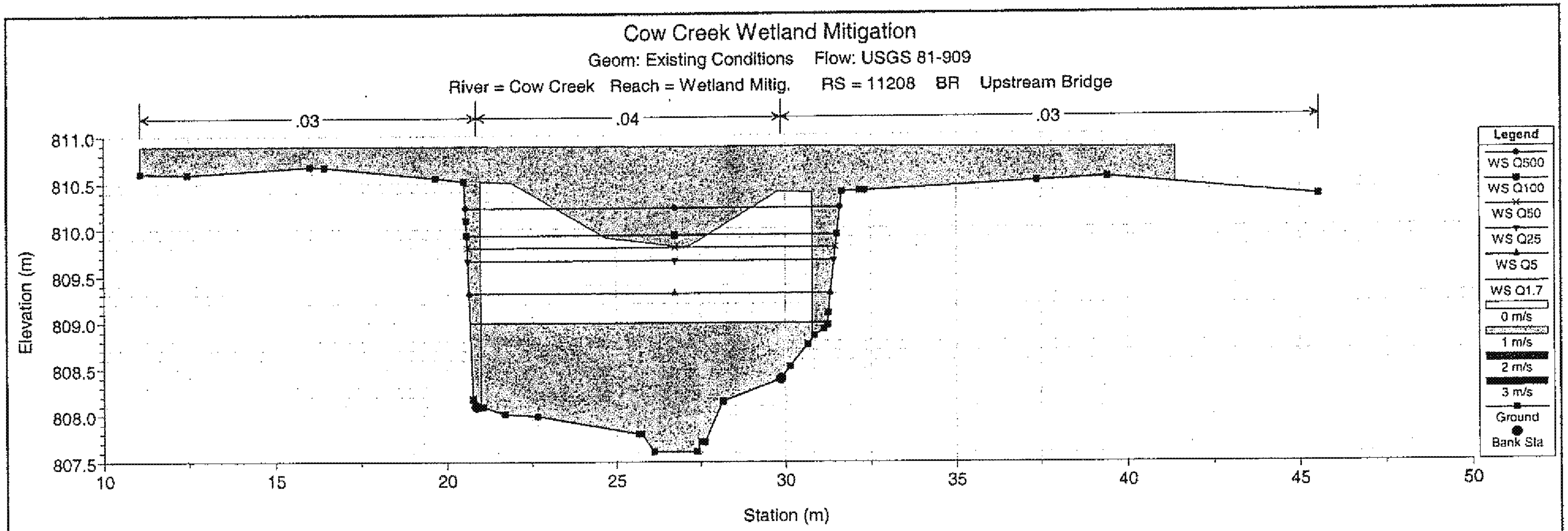

Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11230 XS25
.03
.04
.03
Elevation (m)
Station (m)
Legend
WS Q500
WS Q100
WS Q50
WS Q25
WS Q5
WS Q1.7
0 m/s
1 m/s
2 m/s
3 m/s
Ground
Bank Sta

Cow Creek Wetland Mitigation
Geom: Existing Conditions   Flow: USGS 81-909
River = Cow Creek   Reach = Wetland Mitig.   RS = 11215   XS24

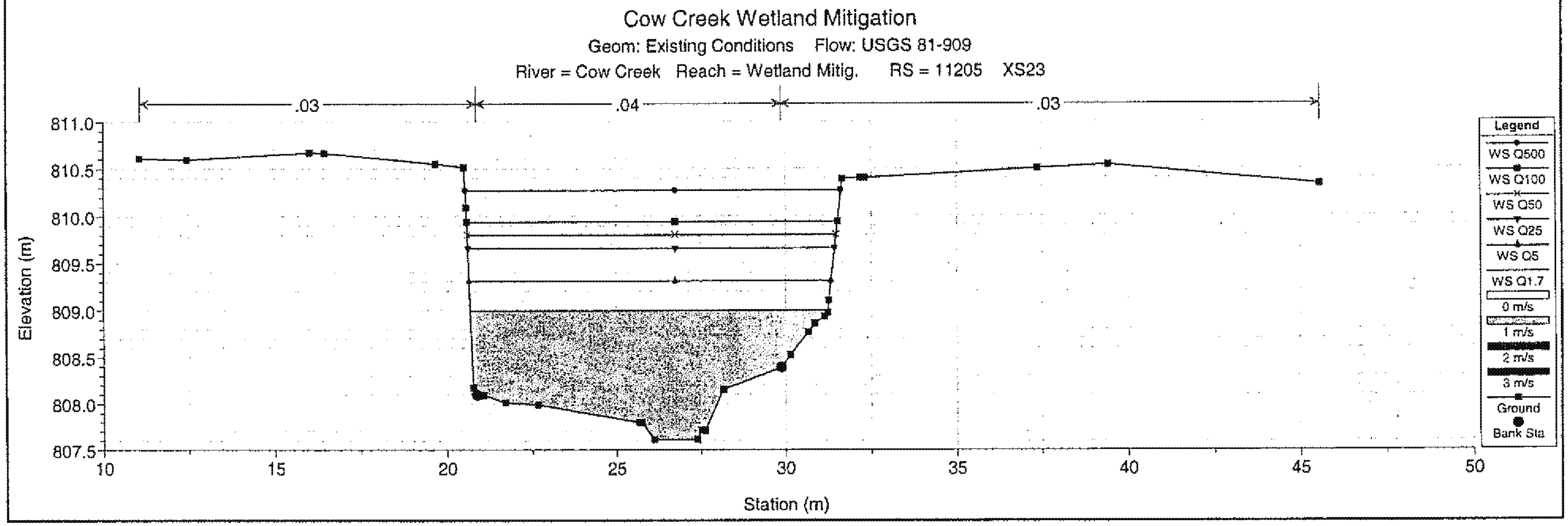


Cow Creek Wetland Mitigation
Geom: Existing Conditions   Flow: USGS 81-909
River = Cow Creek   Reach = Wetland Mitig.   RS = 11208   BR   Upstream Bridge



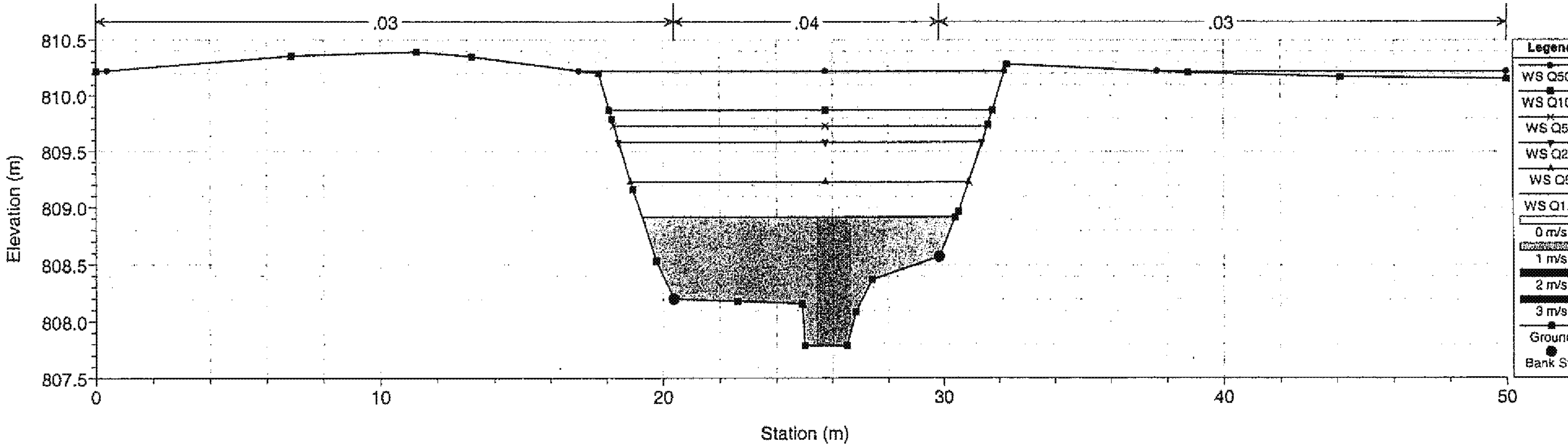


Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11208 BR Upstream Bridge
.03
.04
.03
Elevation (m)
811.0
810.5
810.0
809.5
809.0
808.5
808.0
807.5
Station (m)
10
15
20
25
30
35
40
45
50
Legend
WS Q500
WS Q100
WS Q50
WS Q25
WS Q5
WS Q1.7
0 m/s
1 m/s
2 m/s
3 m/s
Ground
Bank Sta

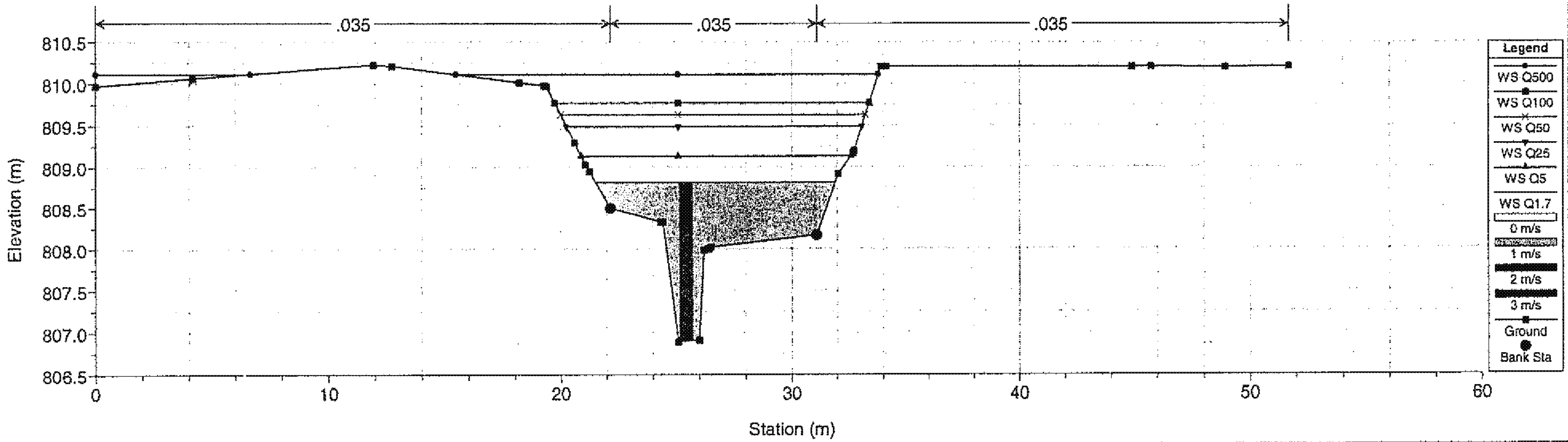


Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11205 XS23
.03
.04
.03
Elevation (m)
811.0
810.5
810.0
809.5
809.0
808.5
808.0
807.5
Station (m)
10
15
20
25
30
35
40
45
50
Legend
WS Q500
WS Q100
WS Q50
WS Q25
WS Q5
WS Q1.7
0 m/s
1 m/s
2 m/s
3 m/s
Ground
Bank Sta

Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11180 XS22



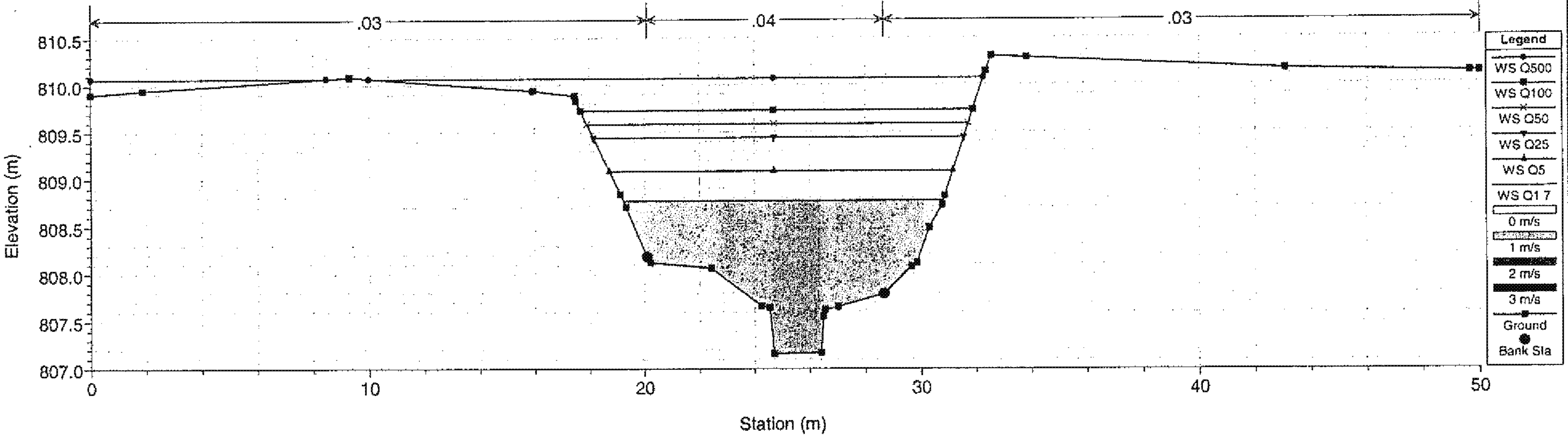
Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11145 XS21



Cow Creek Wetland Mitigation

Geom: Existing Conditions Flow: USGS 81-909

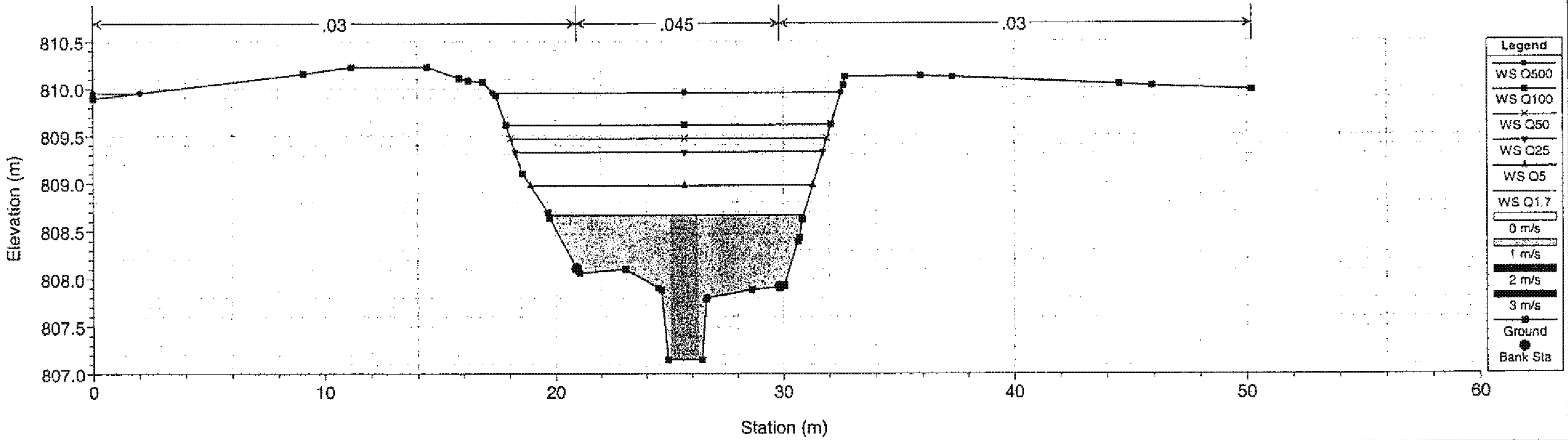
River = Cow Creek Reach = Wetland Mitig. RS = 11105 XS20



Cow Creek Wetland Mitigation

Geom: Existing Conditions Flow: USGS 81-909

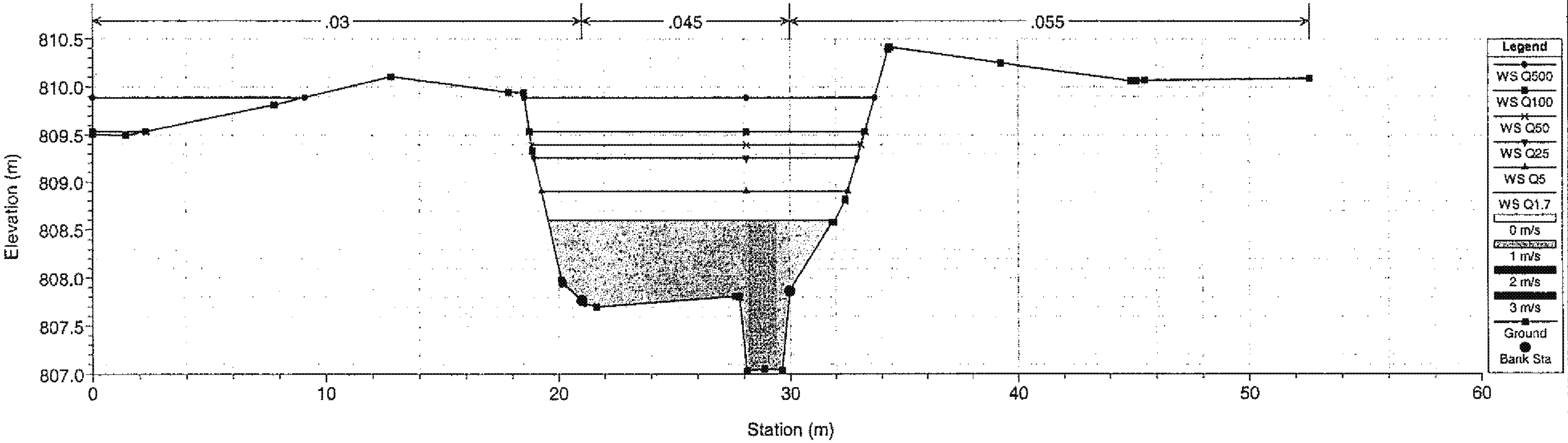
River = Cow Creek Reach = Wetland Mitig. RS = 11060 XS19



Cow Creek Wetland Mitigation

Geom: Existing Conditions Flow: USGS 81-909

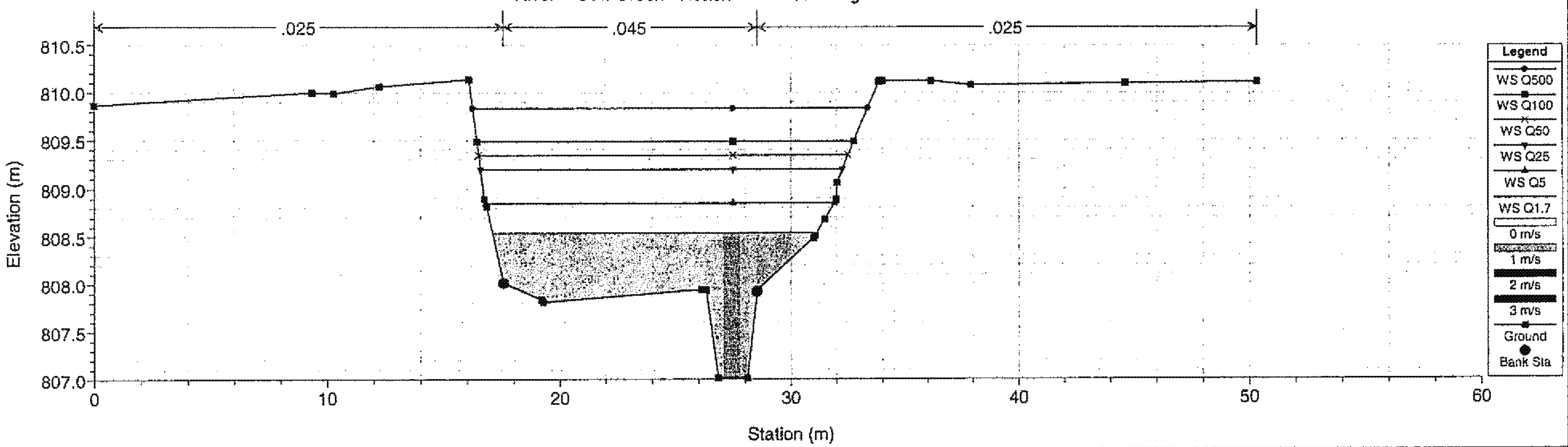
River = Cow Creek Reach = Wetland Mitig. RS = 11025 XS18



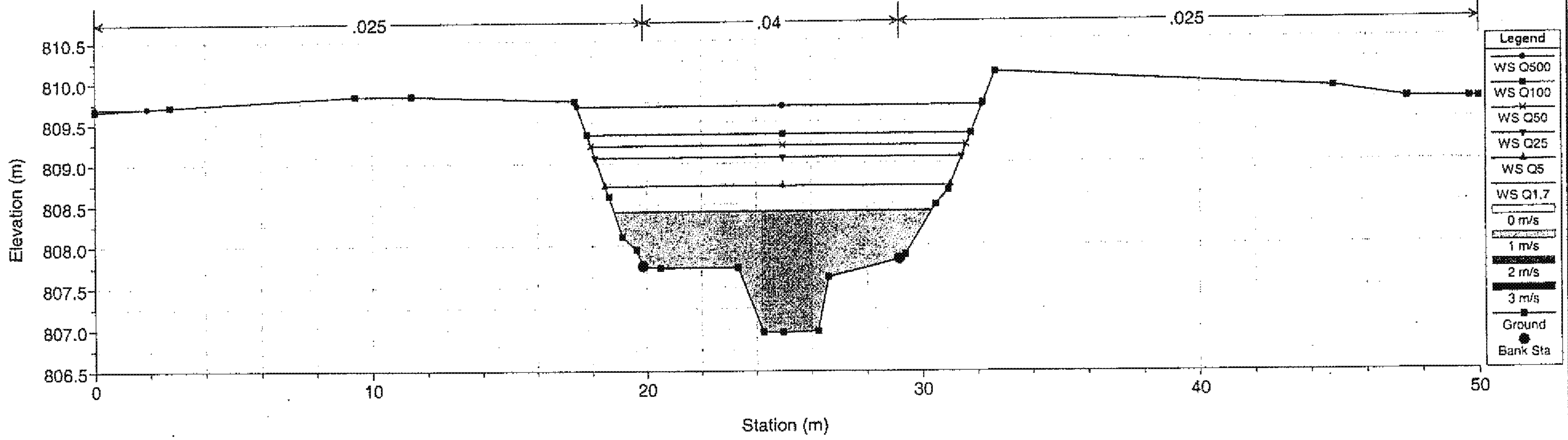
Cow Creek Wetland Mitigation

Geom: Existing Conditions Flow: USGS 81-909

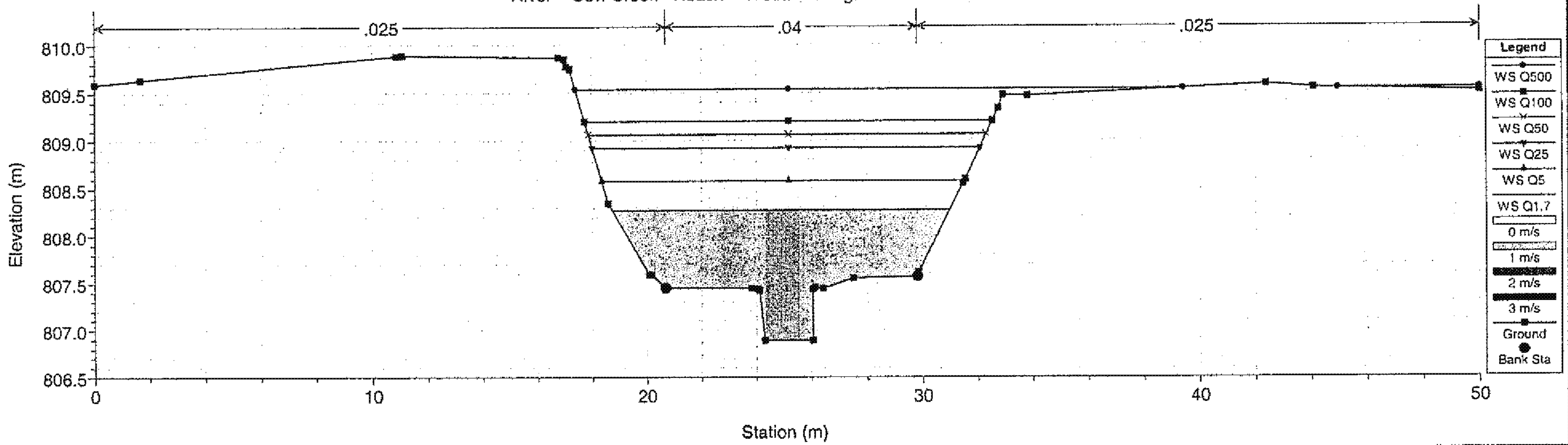
River = Cow Creek Reach = Wetland Mitig. RS = 10995 XS17



Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10940 XS16



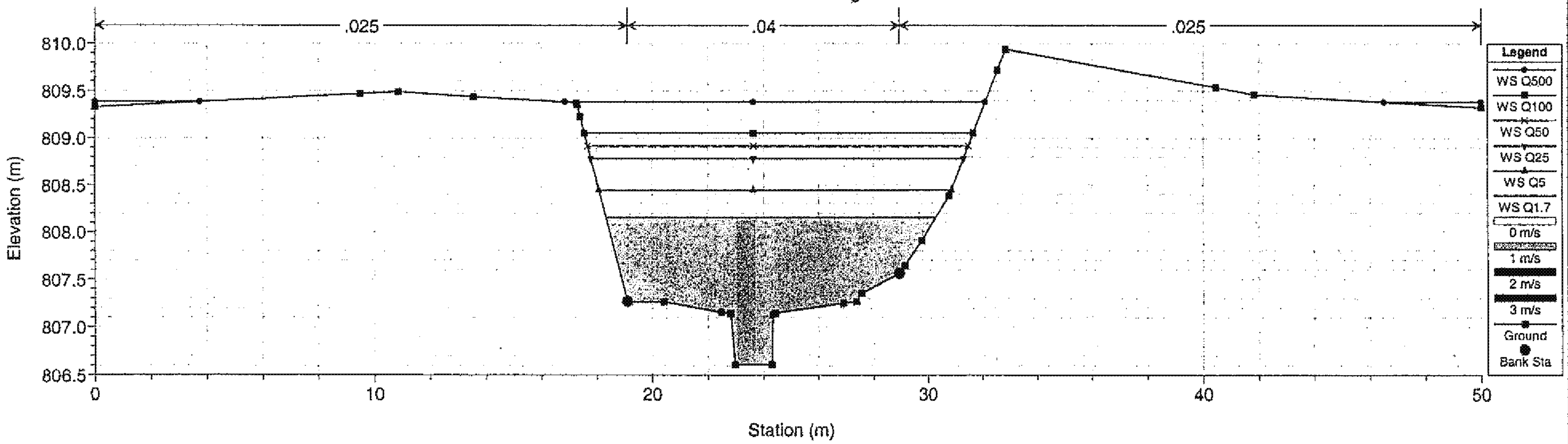
Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10855 XS15



Cow Creek Wetland Mitigation

Geom: Existing Conditions   Flow: USGS 81-909

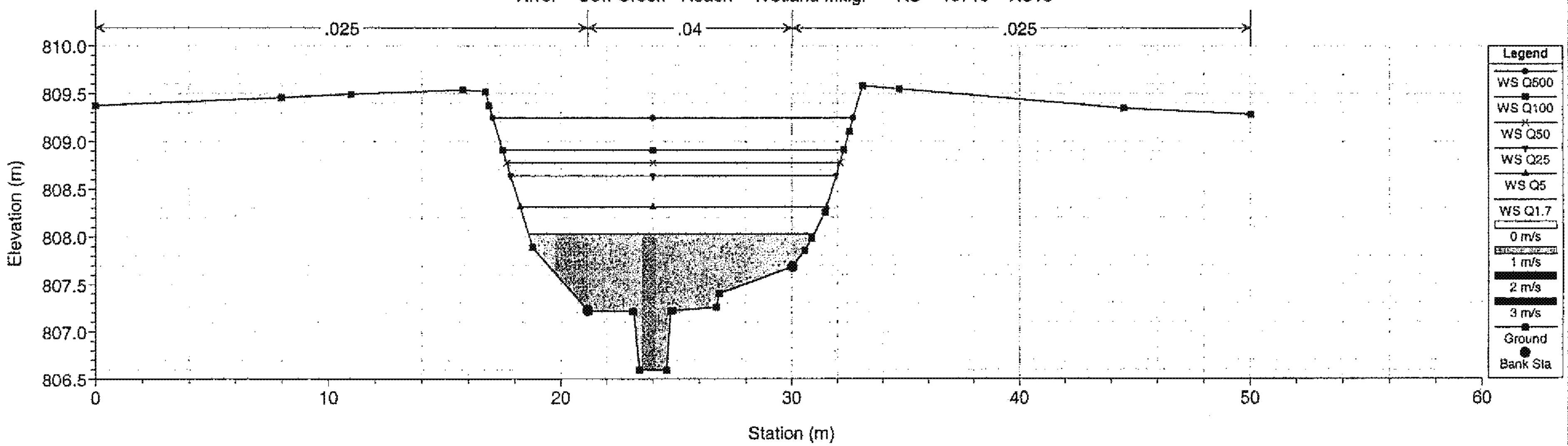
River = Cow Creek   Reach = Wetland Mitig.   RS = 10770   XS14



Cow Creek Wetland Mitigation

Geom: Existing Conditions   Flow: USGS 81-909

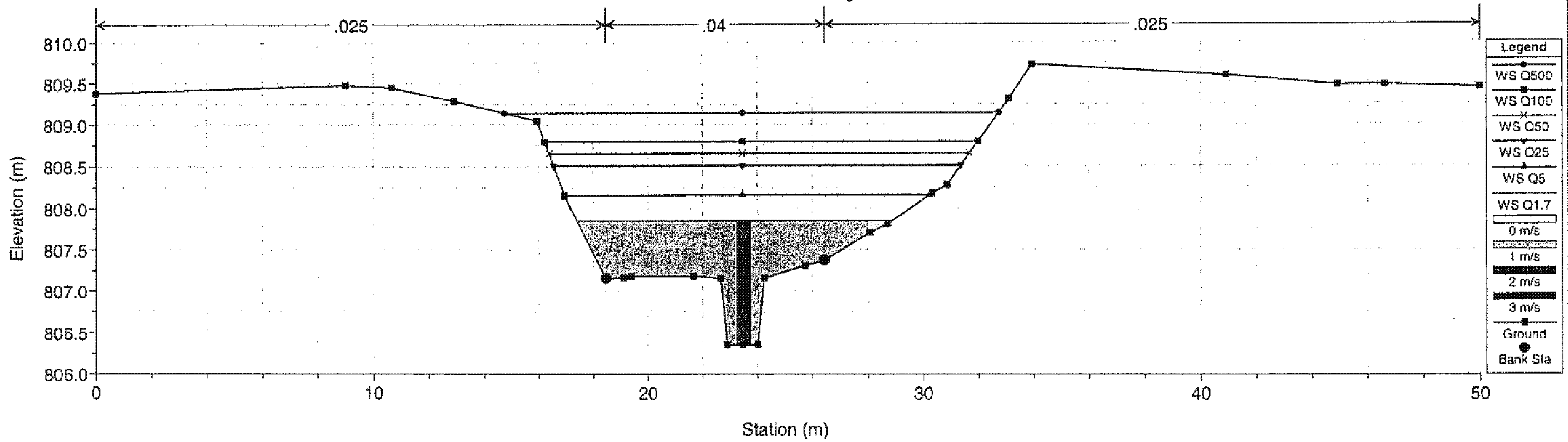
River = Cow Creek   Reach = Wetland Mitig.   RS = 10710   XS13



Cow Creek Wetland Mitigation

Geom: Existing Conditions Flow: USGS 81-909

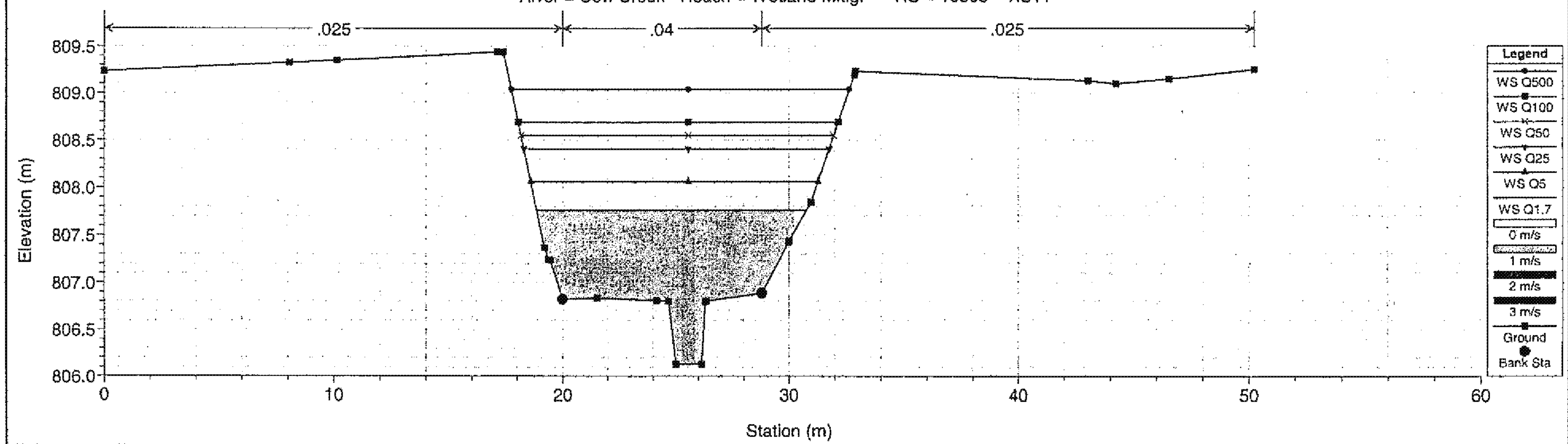
River = Cow Creek Reach = Wetland Mitig. RS = 10660 XS12



Cow Creek Wetland Mitigation

Geom: Existing Conditions Flow: USGS 81-909

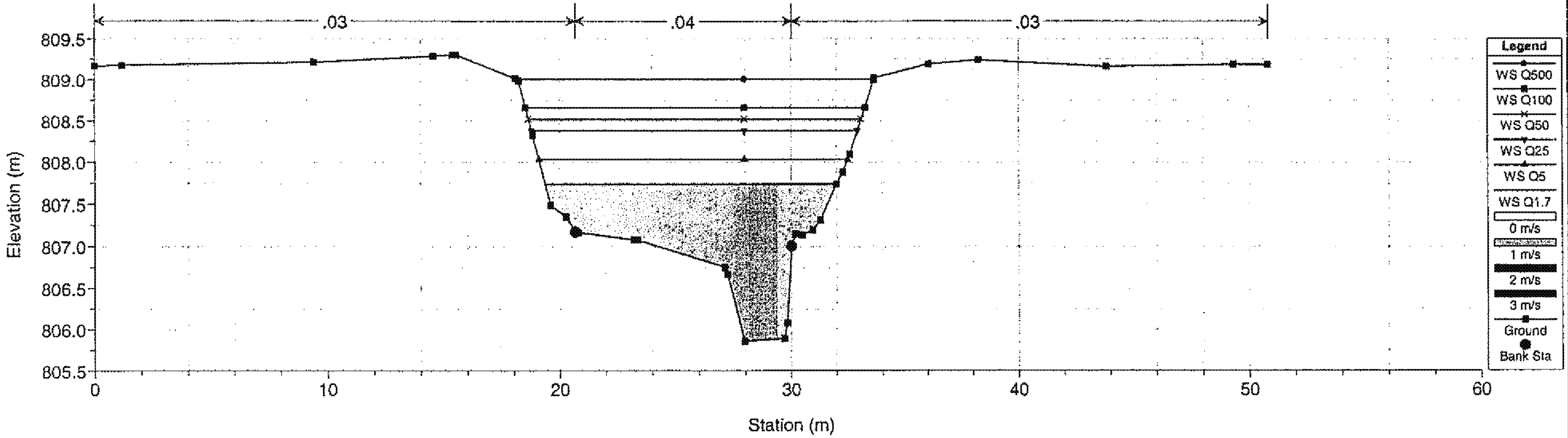
River = Cow Creek Reach = Wetland Mitig. RS = 10595 XS11



Cow Creek Wetland Mitigation

Geom: Existing Conditions Flow: USGS 81-909

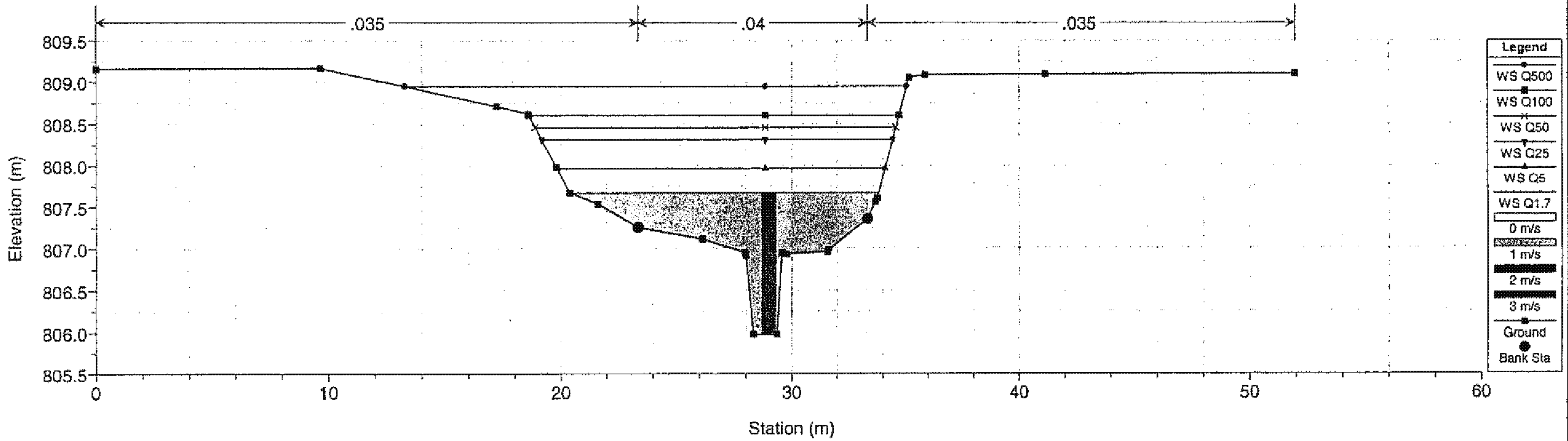
River = Cow Creek Reach = Wetland Mitig. RS = 10575 XS10

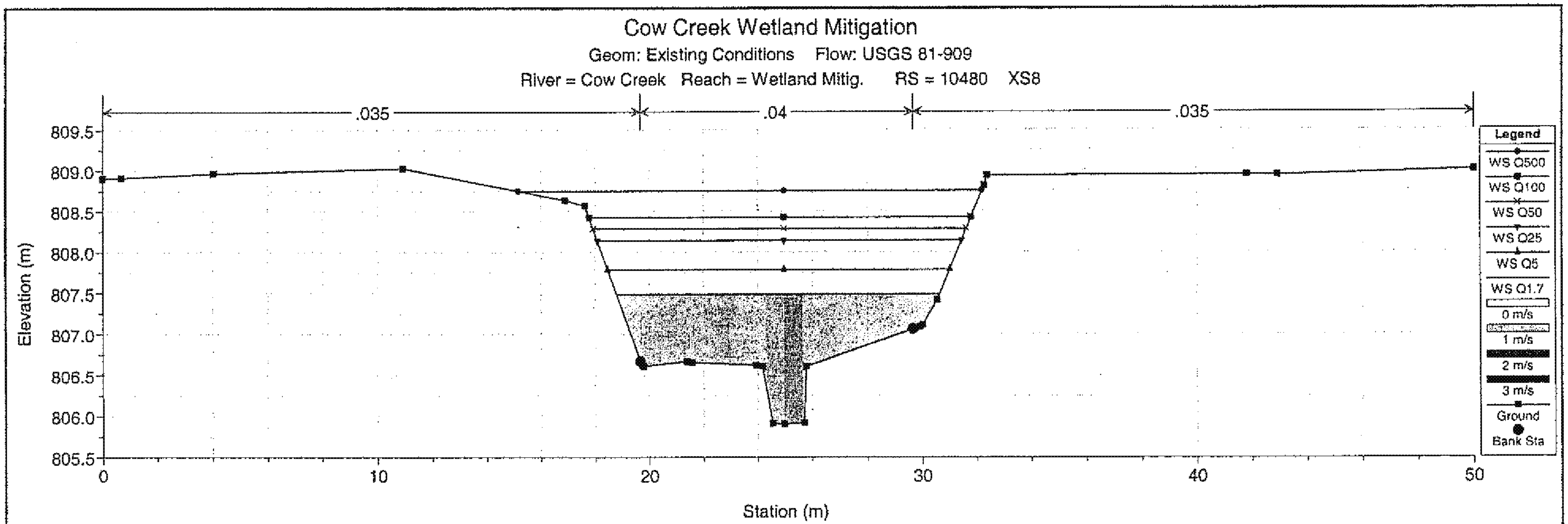


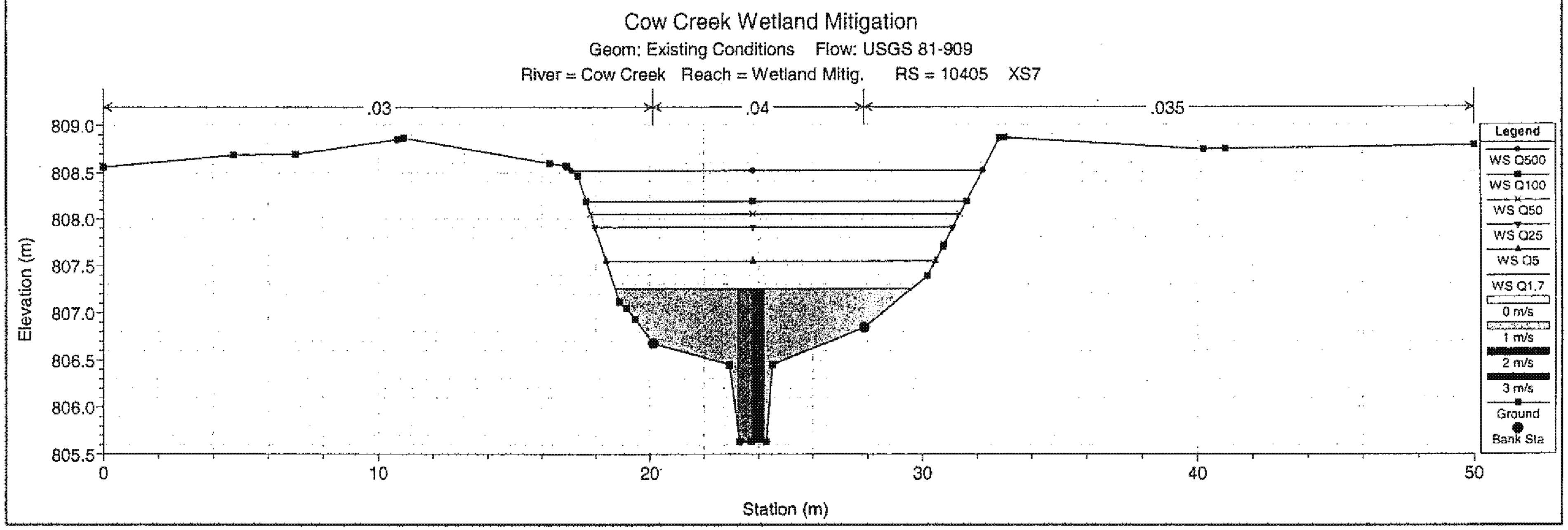
Cow Creek Wetland Mitigation

Geom: Existing Conditions Flow: USGS 81-909

River = Cow Creek Reach = Wetland Mitig. RS = 10555 XS9



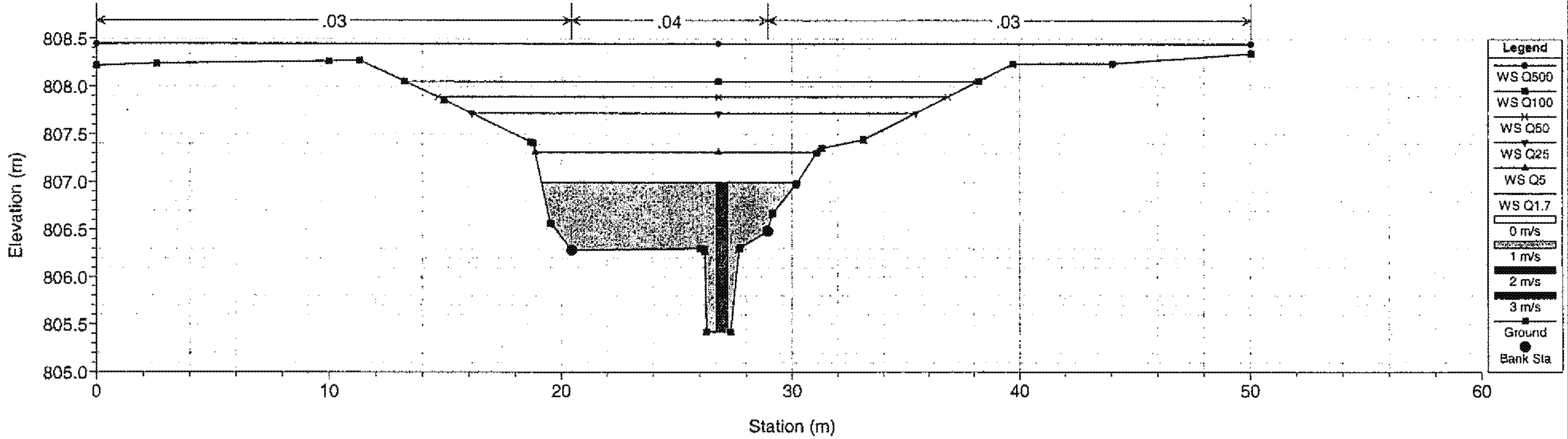

Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10480 XS8
.035
.04
.035
Elevation (m)
Station (m)
Legend
WS Q500
WS Q100
WS Q50
WS Q25
WS Q5
WS Q1.7
0 m/s
1 m/s
2 m/s
3 m/s
Ground
Bank Sta


Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10405 XS7
.03
.04
.035
Elevation (m)
Station (m)
Legend
WS Q500
WS Q100
WS Q50
WS Q25
WS Q5
WS Q1.7
0 m/s
1 m/s
2 m/s
3 m/s
Ground
Bank Sta

Cow Creek Wetland Mitigation

Geom: Existing Conditions Flow: USGS 81-909

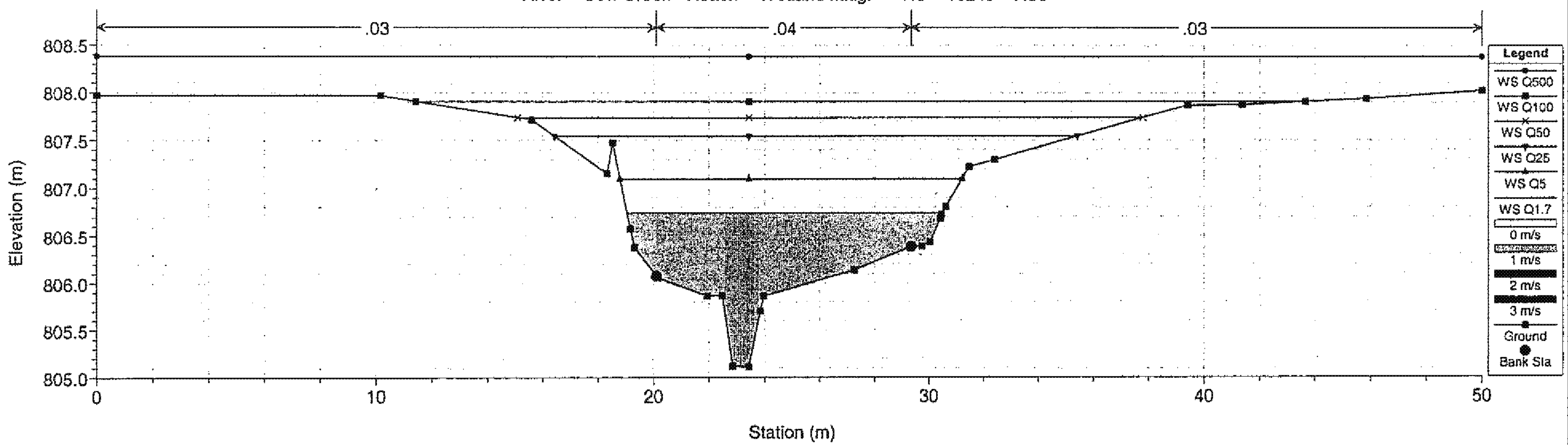
River = Cow Creek Reach = Wetland Mitig. RS = 10330 XS6



Cow Creek Wetland Mitigation

Geom: Existing Conditions Flow: USGS 81-909

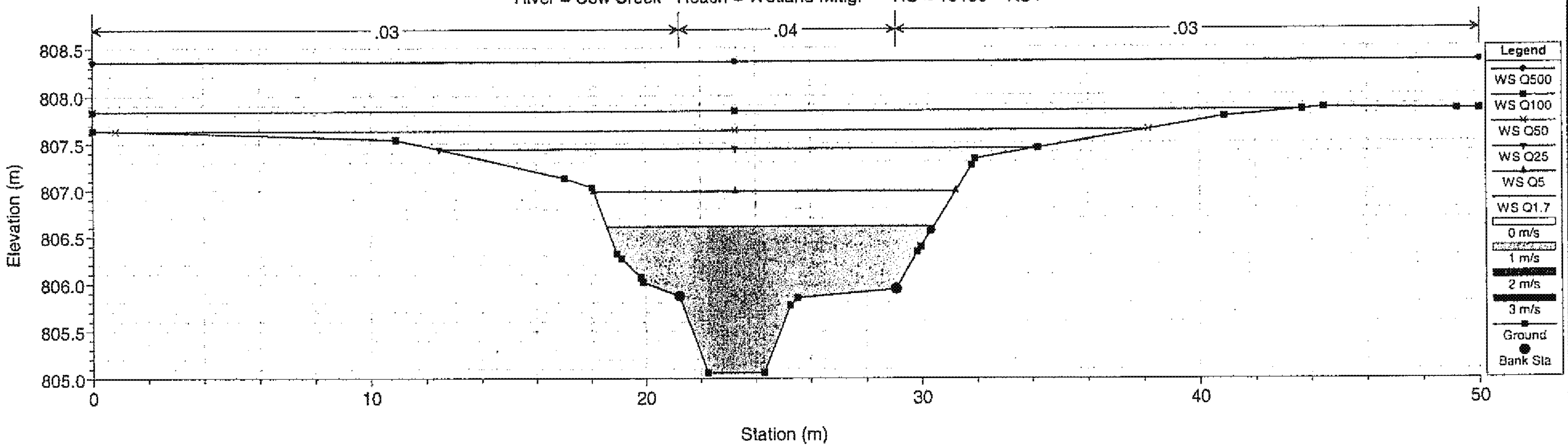
River = Cow Creek Reach = Wetland Mitig. RS = 10240 XS5



Cow Creek Wetland Mitigation

Geom: Existing Conditions Flow: USGS 81-909

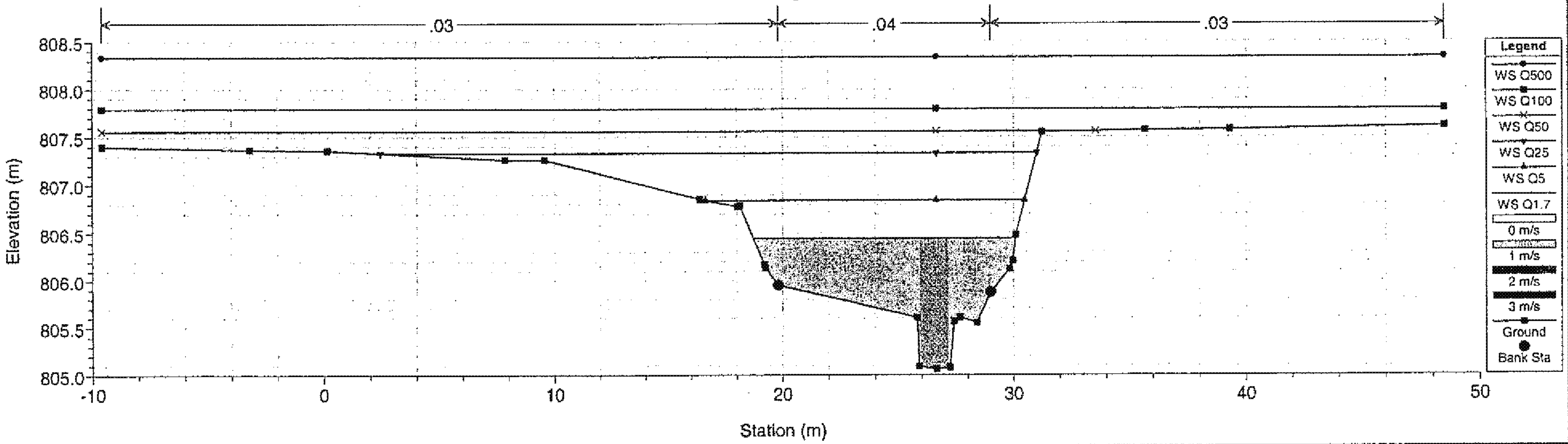
River = Cow Creek Reach = Wetland Mitig. RS = 10160 XS4



Cow Creek Wetland Mitigation

Geom: Existing Conditions Flow: USGS 81-909

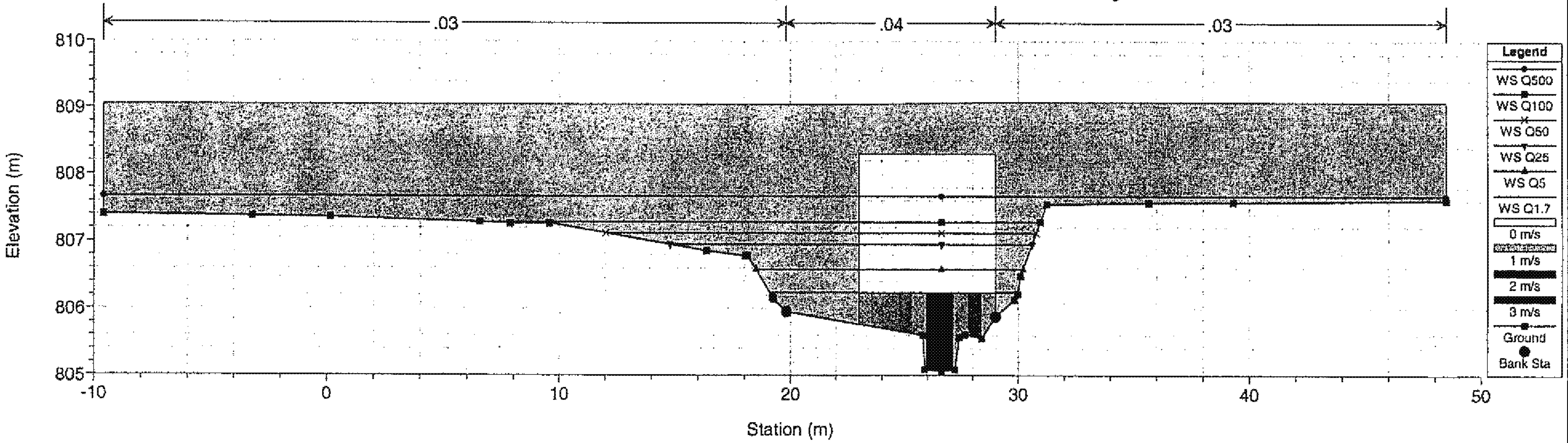
River = Cow Creek Reach = Wetland Mitig. RS = 10080 XS3 Above Bridge



Cow Creek Wetland Mitigation

Geom: Existing Conditions   Flow: USGS 81-909

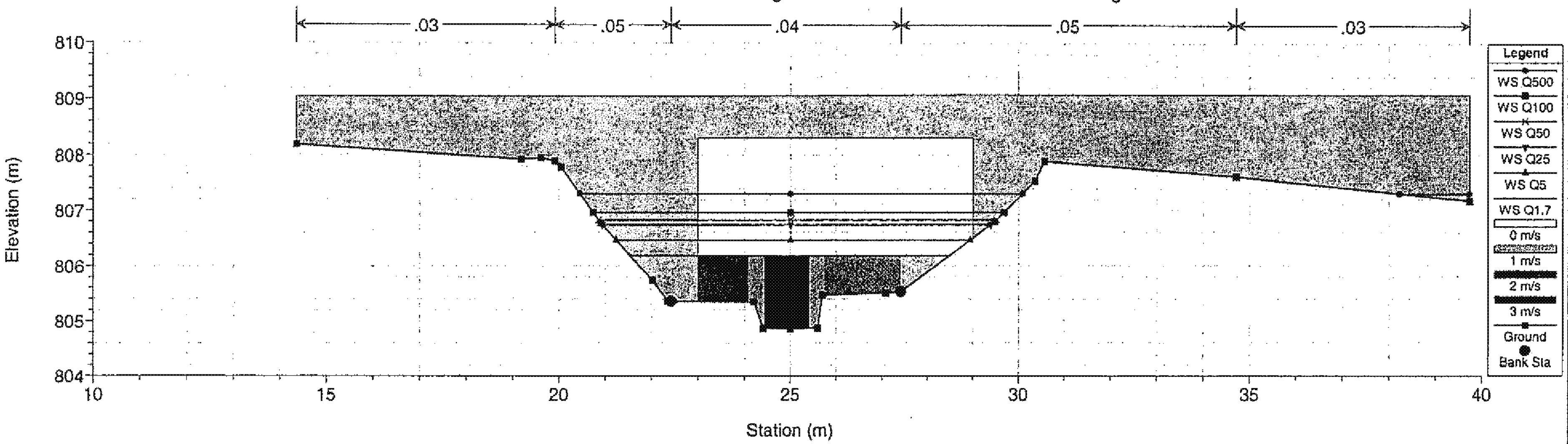
River = Cow Creek   Reach = Wetland Mitig.   RS = 10067   BR   Downstream Bridge



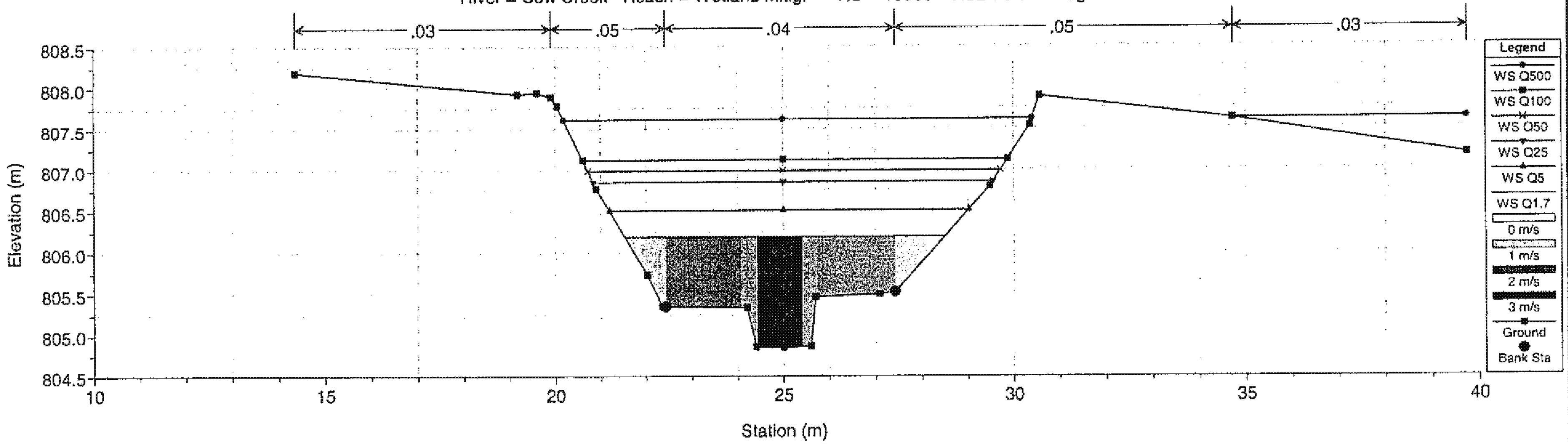
Cow Creek Wetland Mitigation

Geom: Existing Conditions   Flow: USGS 81-909

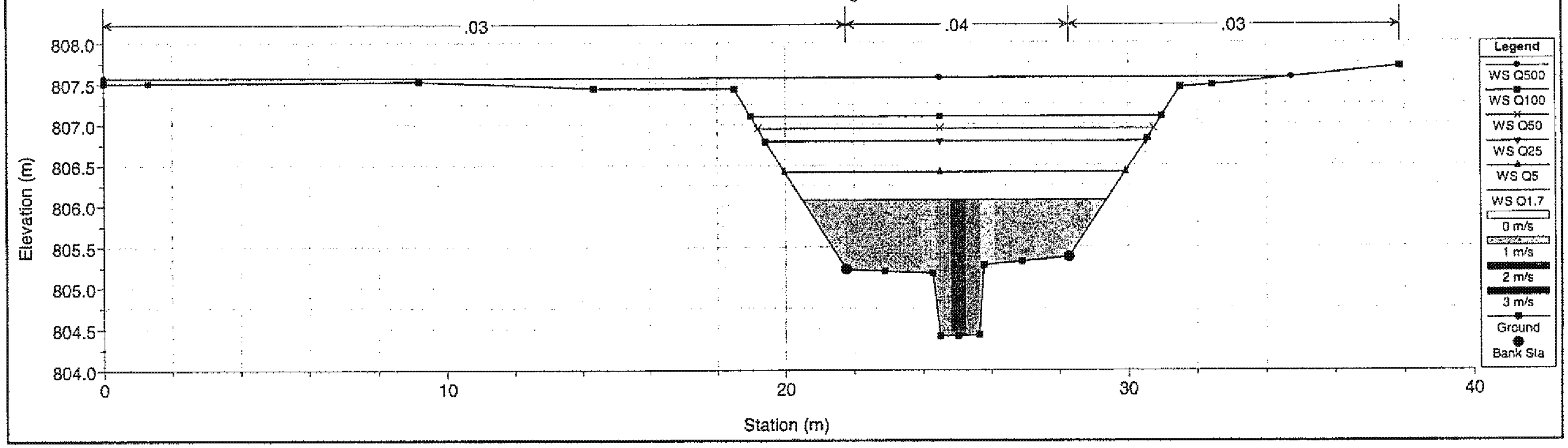
River = Cow Creek   Reach = Wetland Mitig.   RS = 10067   BR   Downstream Bridge



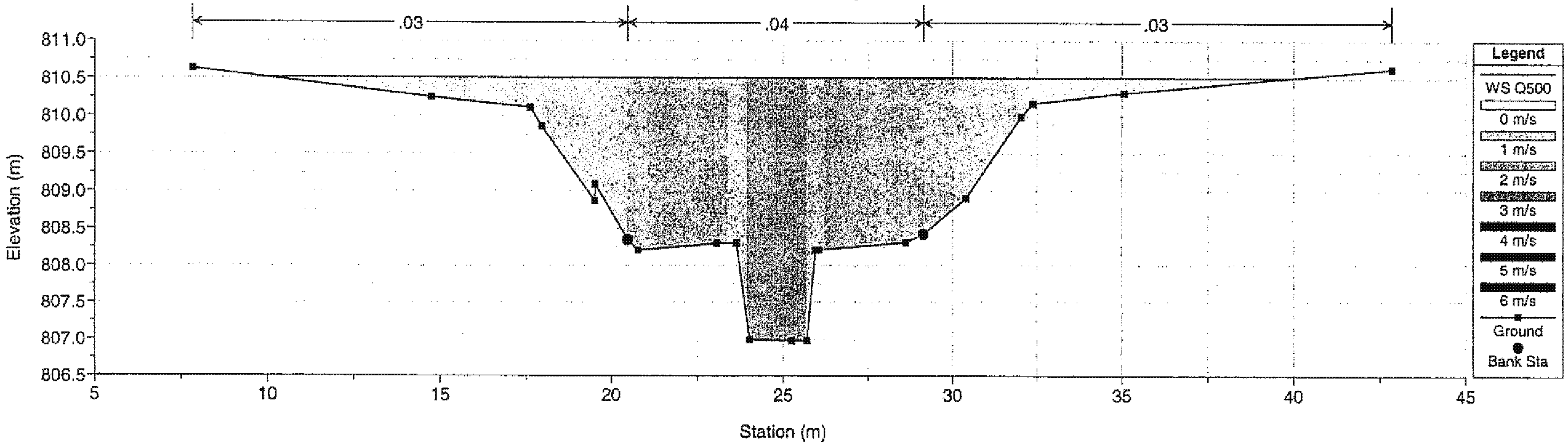
Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10060 XS2 Below Bridge



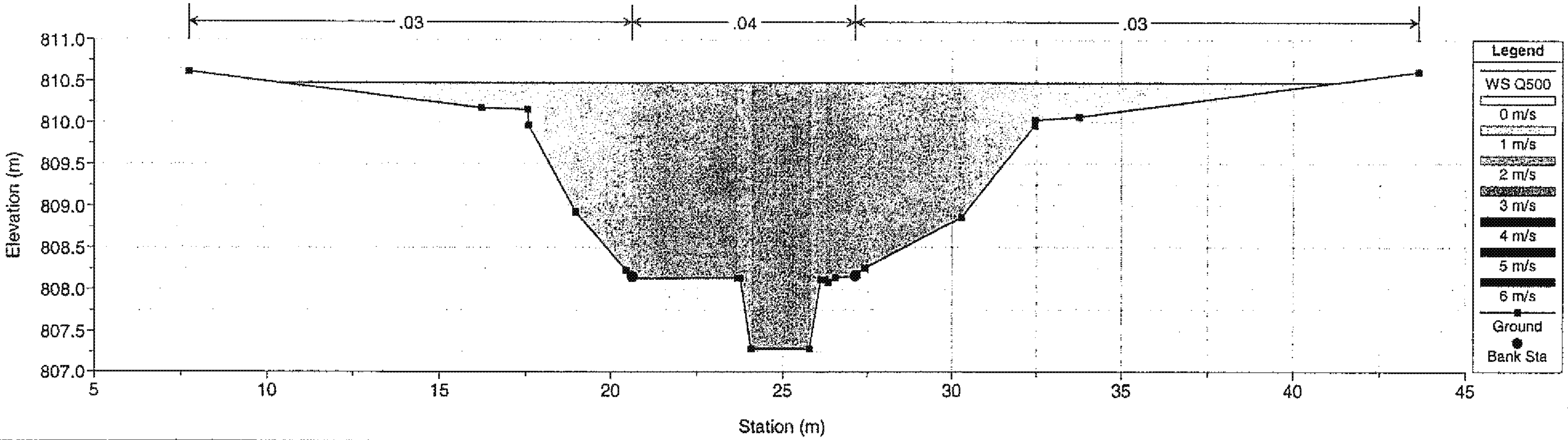
Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10020 XS1

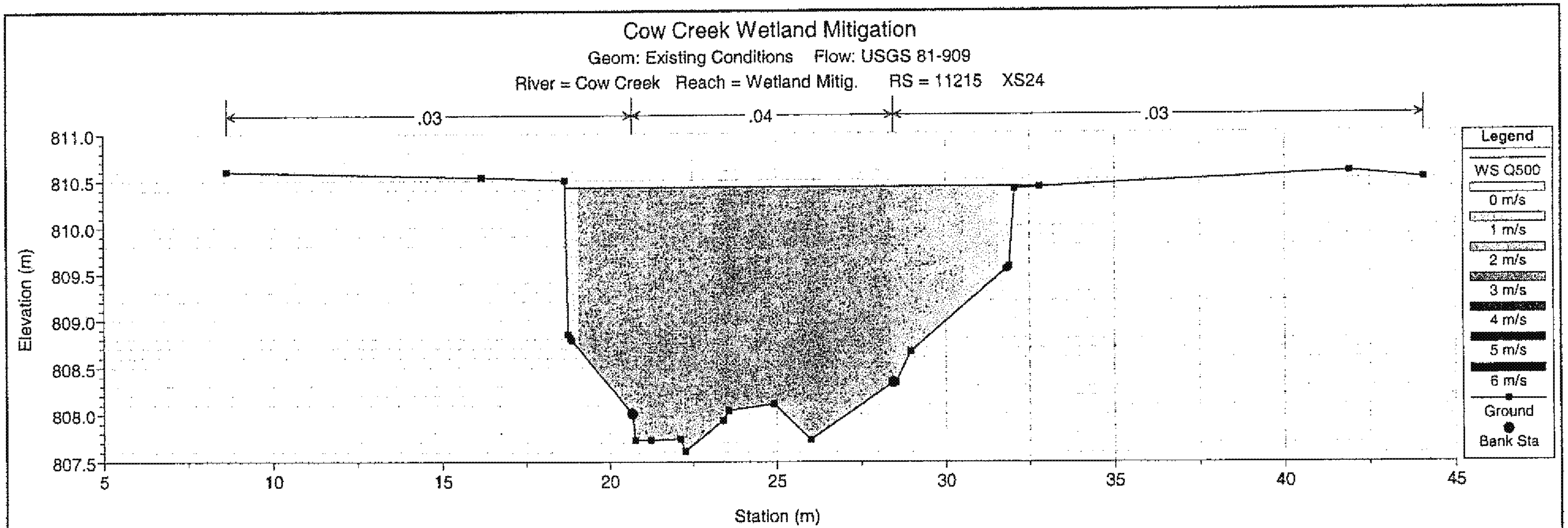


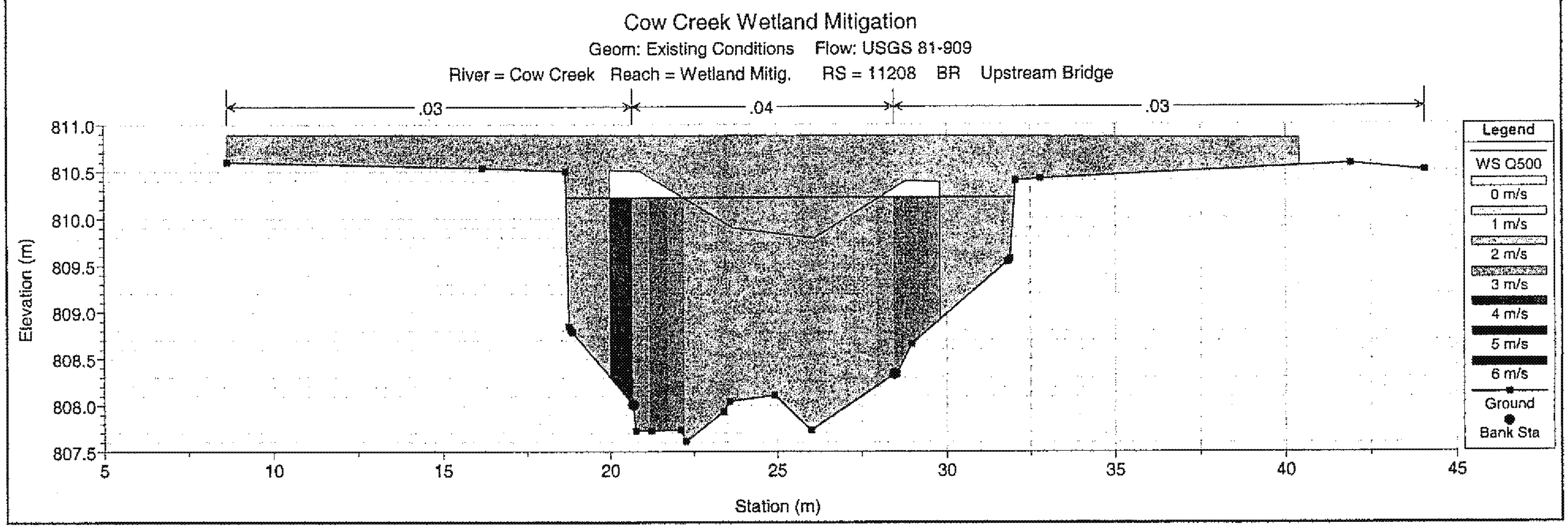
Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11255 XS26



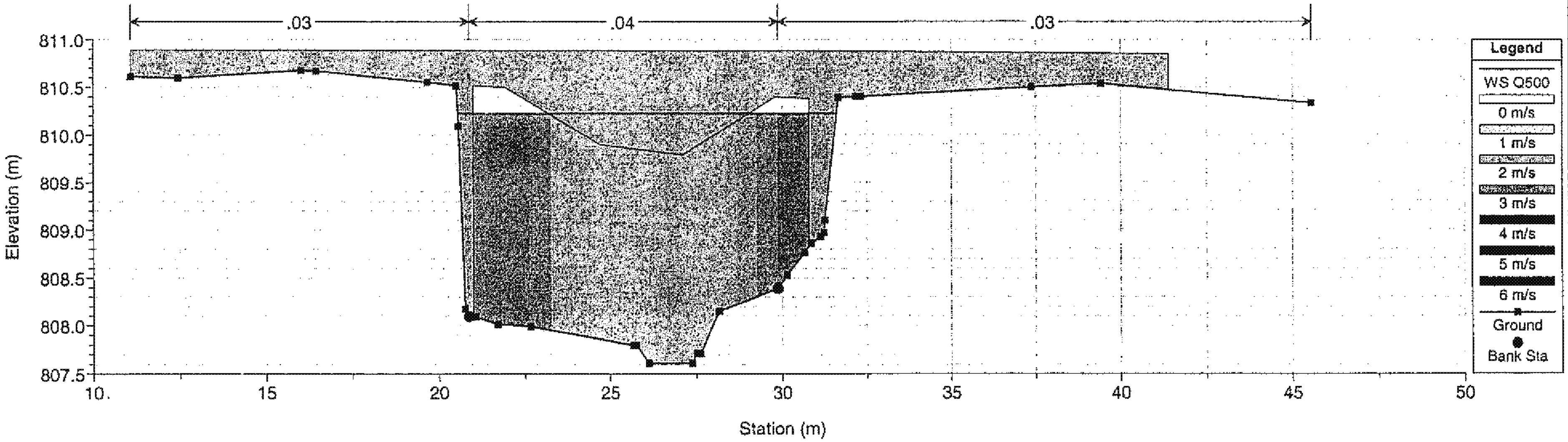
Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11230 XS25



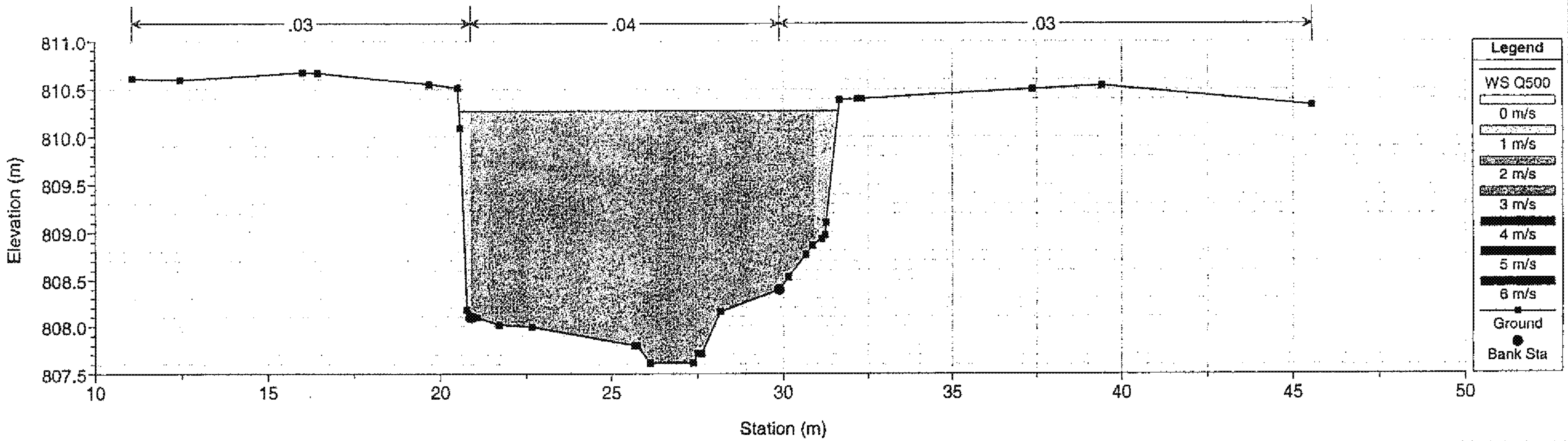

Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11215 XS24
.03
.04
.03
Elevation (m)
811.0
810.5
810.0
809.5
809.0
808.5
808.0
807.5
5
10
15
20
25
30
35
40
45
Station (m)
Legend
WS Q500
0 m/s
1 m/s
2 m/s
3 m/s
4 m/s
5 m/s
6 m/s
Ground
Bank Sta

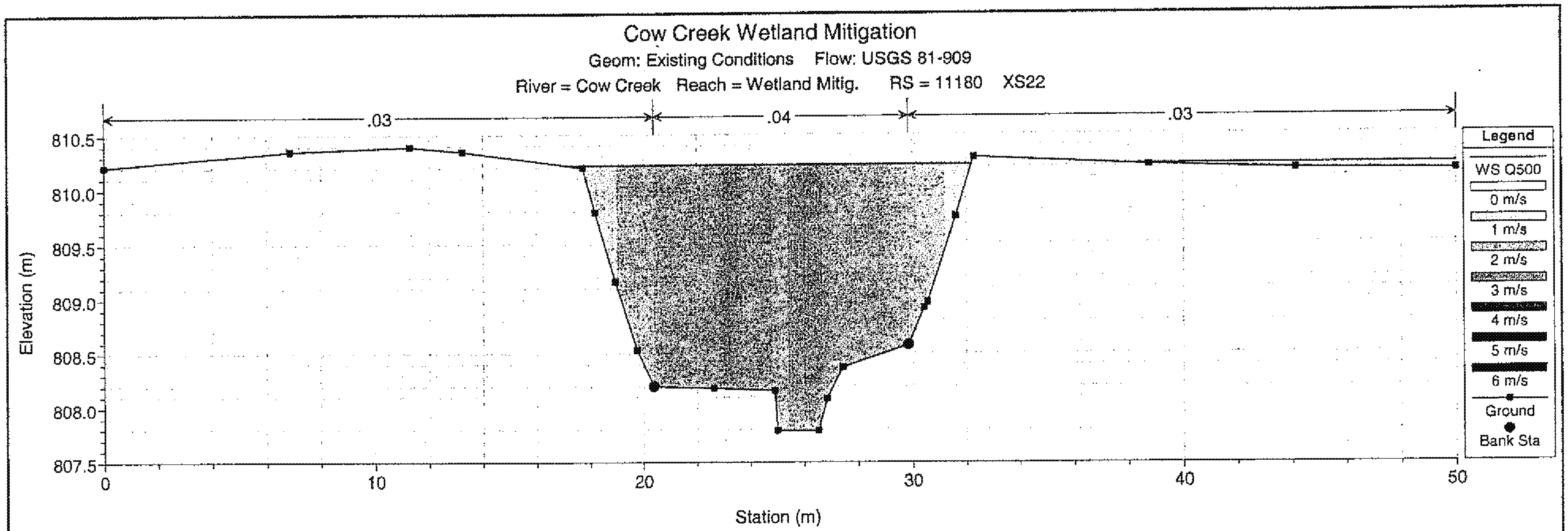

Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11208 BR Upstream Bridge
.03
.04
.03
Elevation (m)
811.0
810.5
810.0
809.5
809.0
808.5
808.0
807.5
5
10
15
20
25
30
35
40
45
Station (m)
Legend
WS Q500
0 m/s
1 m/s
2 m/s
3 m/s
4 m/s
5 m/s
6 m/s
Ground
Bank Sta

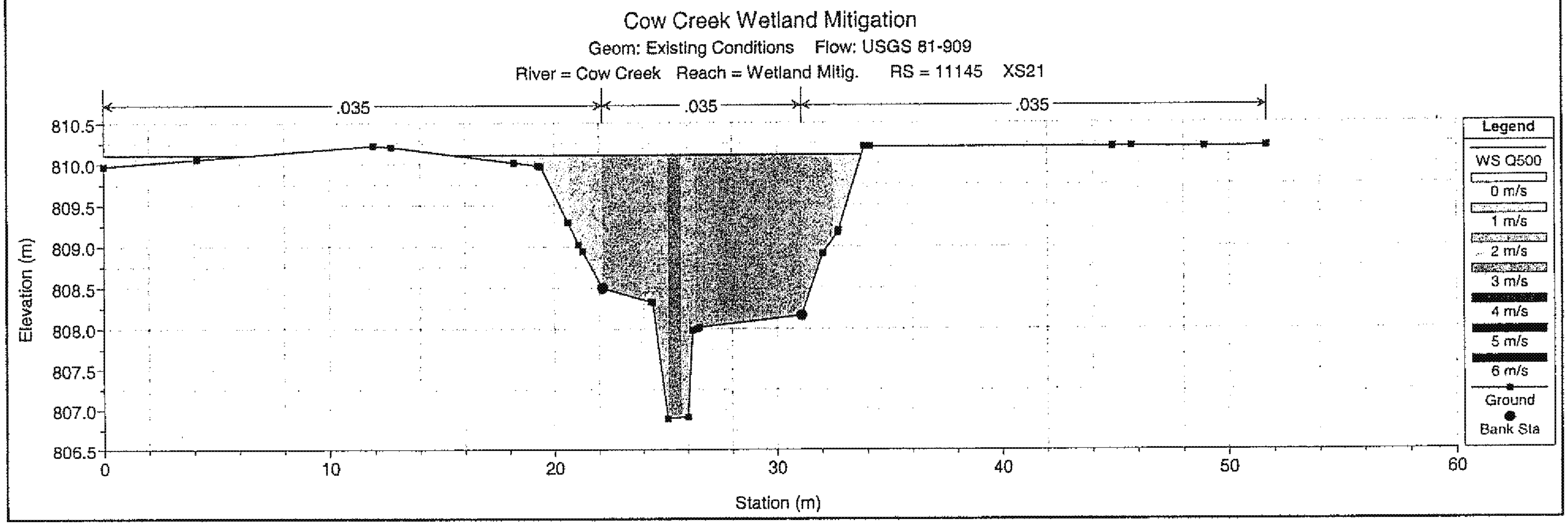
Cow Creek Wetland Mitigation
Geom: Existing Conditions   Flow: USGS 81-909
River = Cow Creek   Reach = Wetland Mitig.   RS = 11208   BR   Upstream Bridge



Cow Creek Wetland Mitigation
Geom: Existing Conditions   Flow: USGS 81-909
River = Cow Creek   Reach = Wetland Mitig.   RS = 11205   XS23



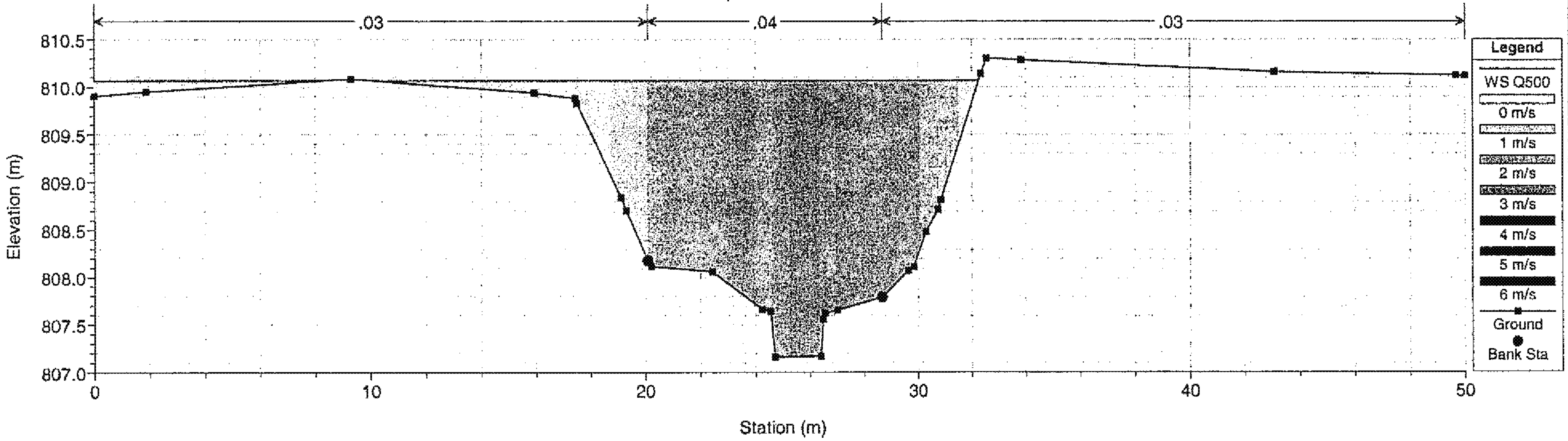

Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11180 XS22
.03
.04
.03
Elevation (m)
810.5
810.0
809.5
809.0
808.5
808.0
807.5
0
10
20
30
40
50
Station (m)
Legend
WS Q500
0 m/s
1 m/s
2 m/s
3 m/s
4 m/s
5 m/s
6 m/s
Ground
Bank Sta


Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11145 XS21
.035
.035
.035
Elevation (m)
810.5
810.0
809.5
809.0
808.5
808.0
807.5
807.0
806.5
0
10
20
30
40
50
60
Station (m)
Legend
WS Q500
0 m/s
1 m/s
2 m/s
3 m/s
4 m/s
5 m/s
6 m/s
Ground
Bank Sta

Cow Creek Wetland Mitigation

Geom: Existing Conditions Flow: USGS 81-909

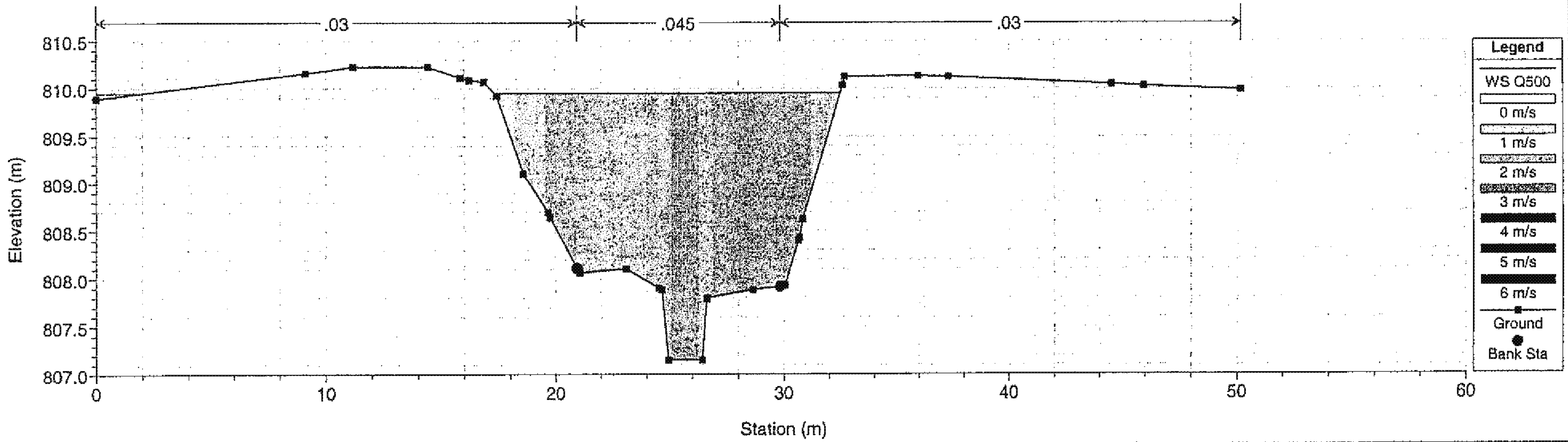
River = Cow Creek Reach = Wetland Mitig. RS = 11105 XS20



Cow Creek Wetland Mitigation

Geom: Existing Conditions Flow: USGS 81-909

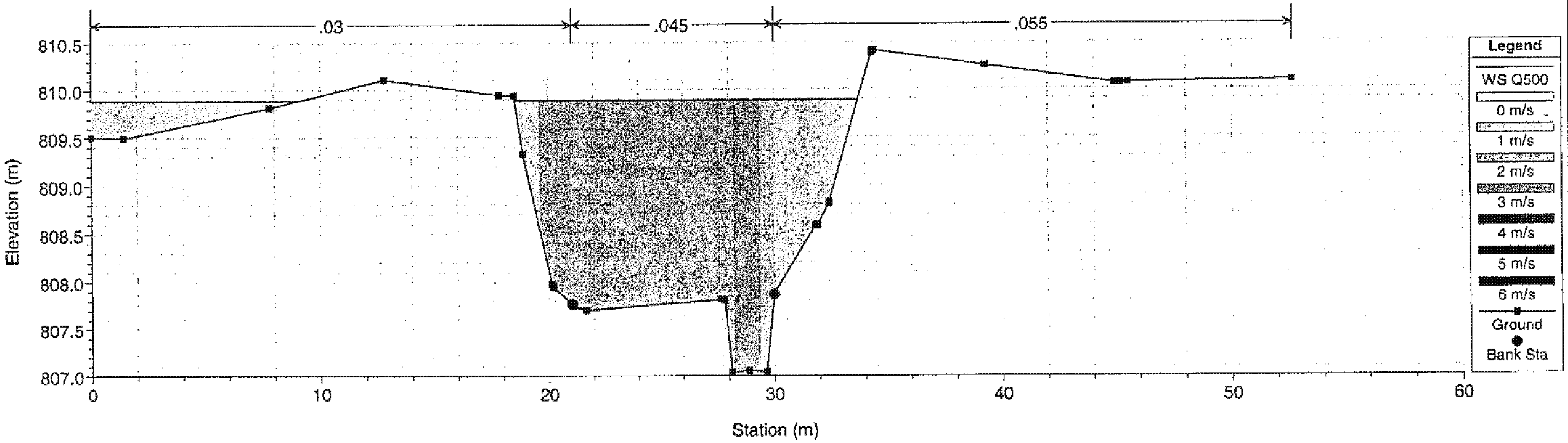
River = Cow Creek Reach = Wetland Mitig. RS = 11060 XS19



Cow Creek Wetland Mitigation

Geom: Existing Conditions Flow: USGS 81-909

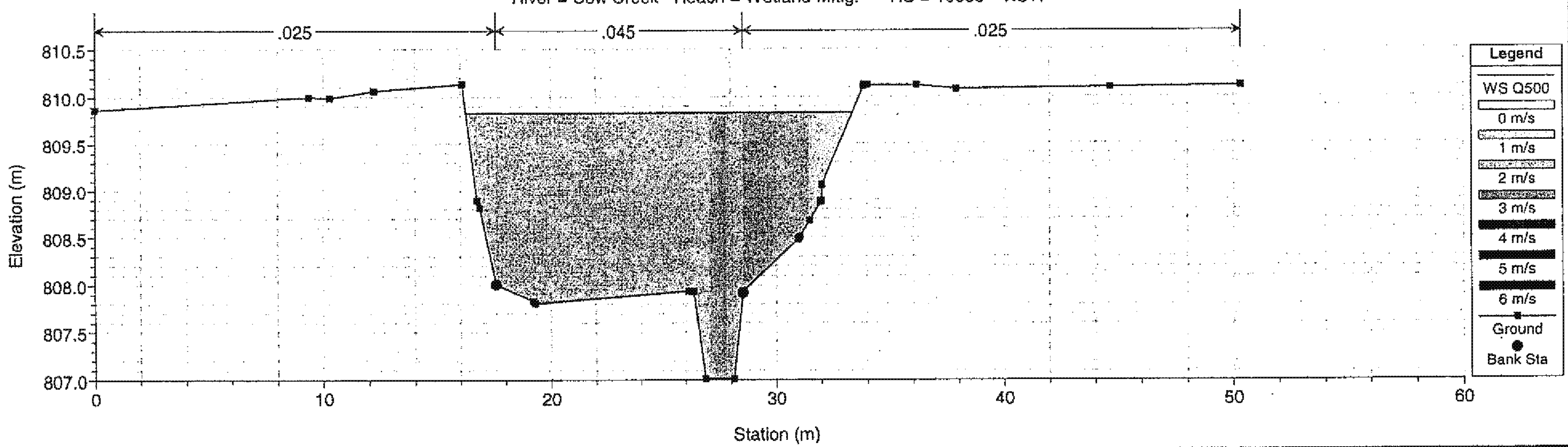
River = Cow Creek Reach = Wetland Mitig. RS = 11025 XS18



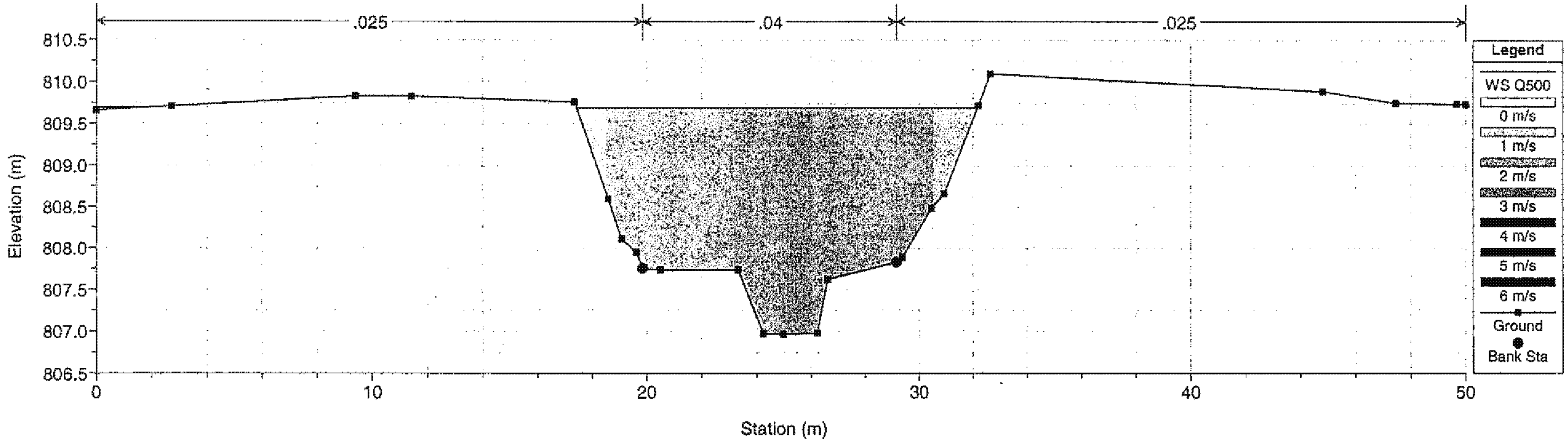
Cow Creek Wetland Mitigation

Geom: Existing Conditions Flow: USGS 81-909

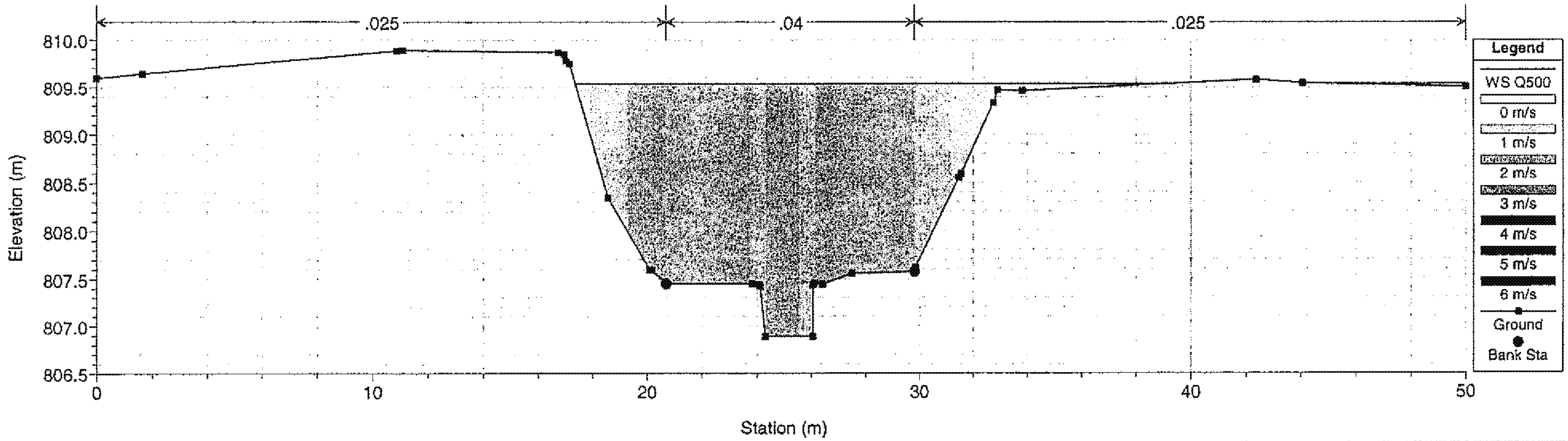
River = Cow Creek Reach = Wetland Mitig. RS = 10995 XS17

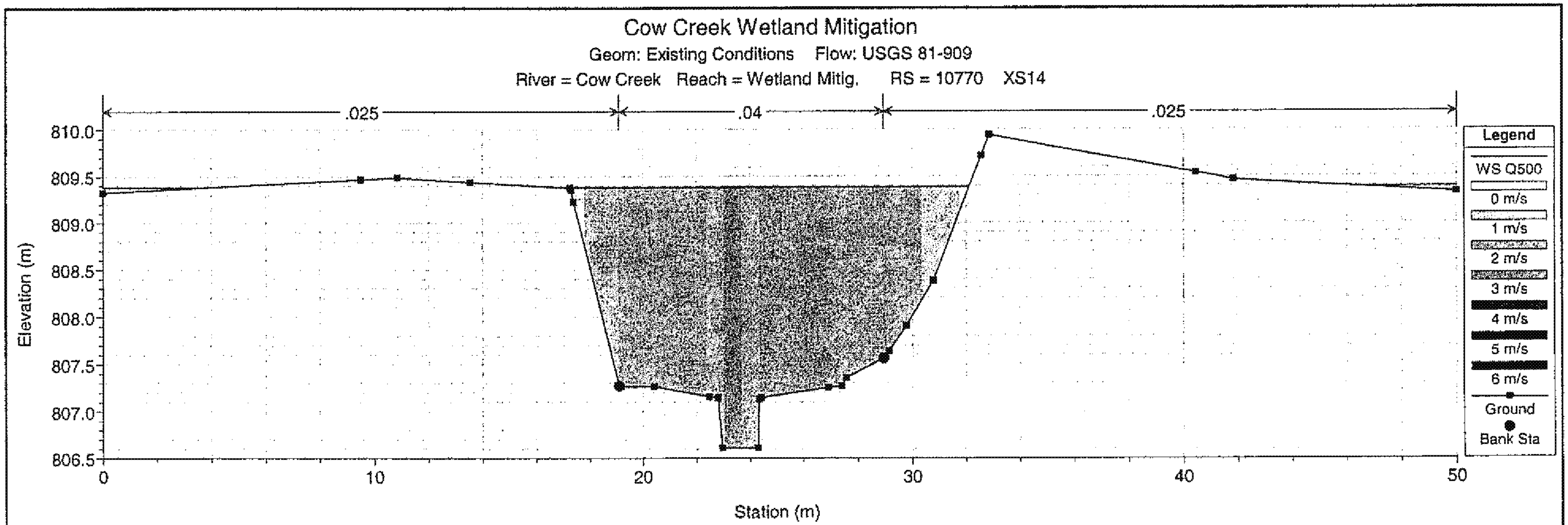


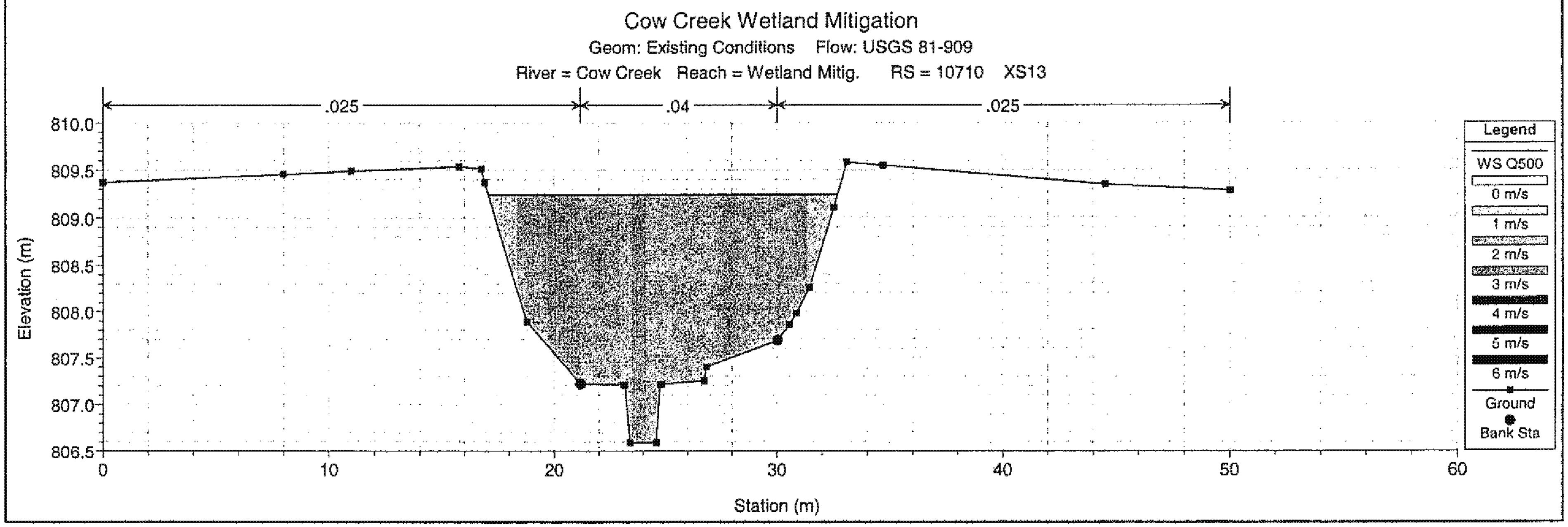
Cow Creek Wetland Mitigation
Geom: Existing Conditions   Flow: USGS 81-909
River = Cow Creek   Reach = Wetland Mitig.   RS = 10940   XS16



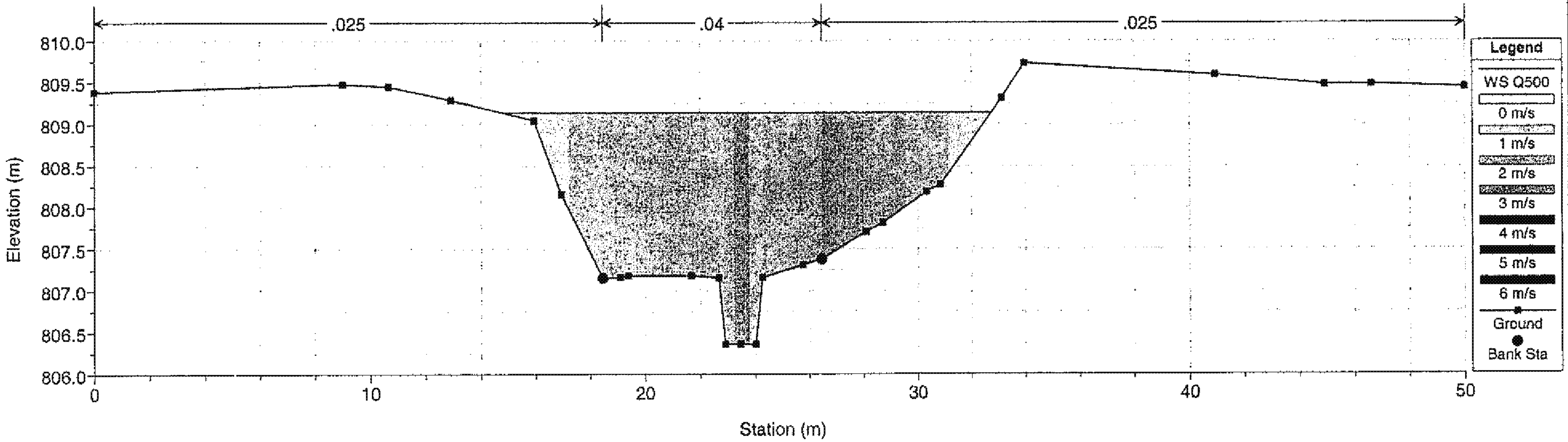
Cow Creek Wetland Mitigation
Geom: Existing Conditions   Flow: USGS 81-909
River = Cow Creek   Reach = Wetland Mitig.   RS = 10855   XS15



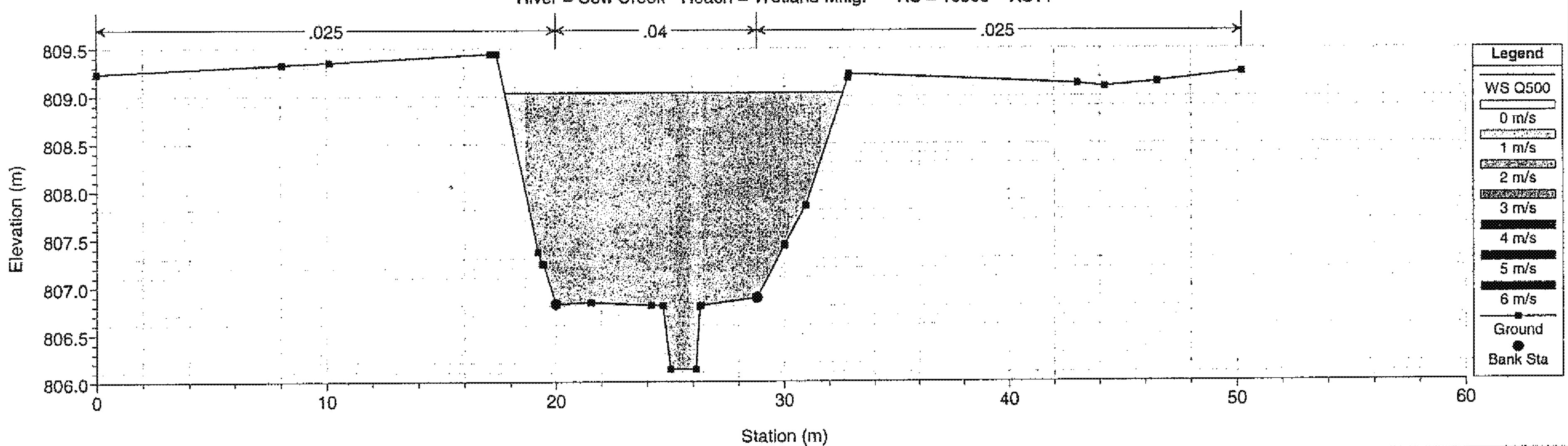

Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10770 XS14
.025
.04
.025
Elevation (m)
810.0
809.5
809.0
808.5
808.0
807.5
807.0
806.5
Station (m)
0
10
20
30
40
50
Legend
WS Q500
0 m/s
1 m/s
2 m/s
3 m/s
4 m/s
5 m/s
6 m/s
Ground
Bank Sta


Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10710 XS13
.025
.04
.025
Elevation (m)
810.0
809.5
809.0
808.5
808.0
807.5
807.0
806.5
Station (m)
0
10
20
30
40
50
60
Legend
WS Q500
0 m/s
1 m/s
2 m/s
3 m/s
4 m/s
5 m/s
6 m/s
Ground
Bank Sta

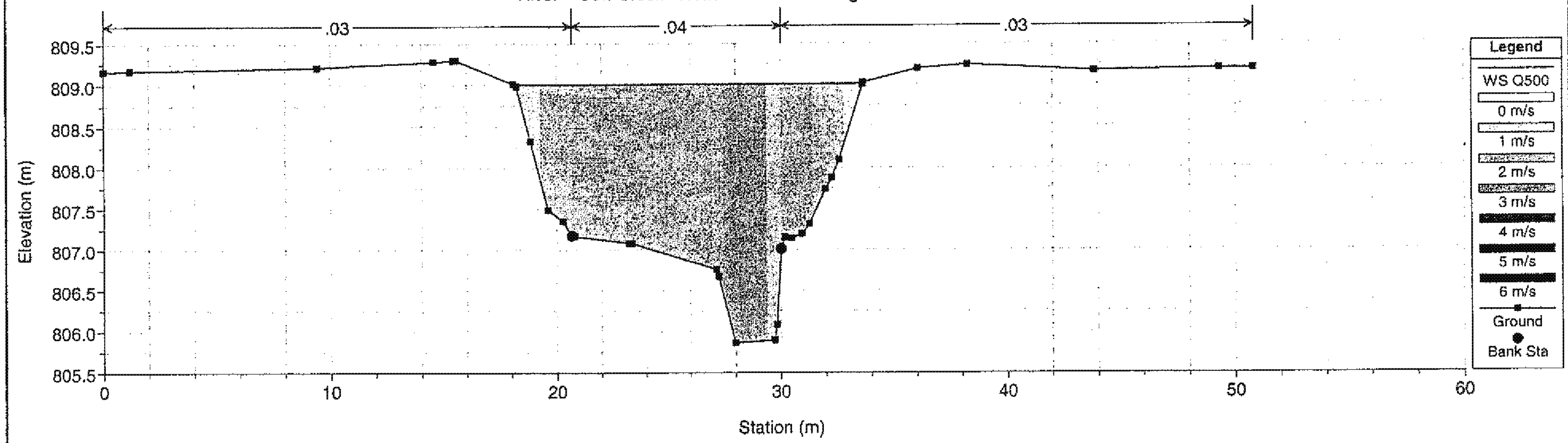
Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10660 XS12



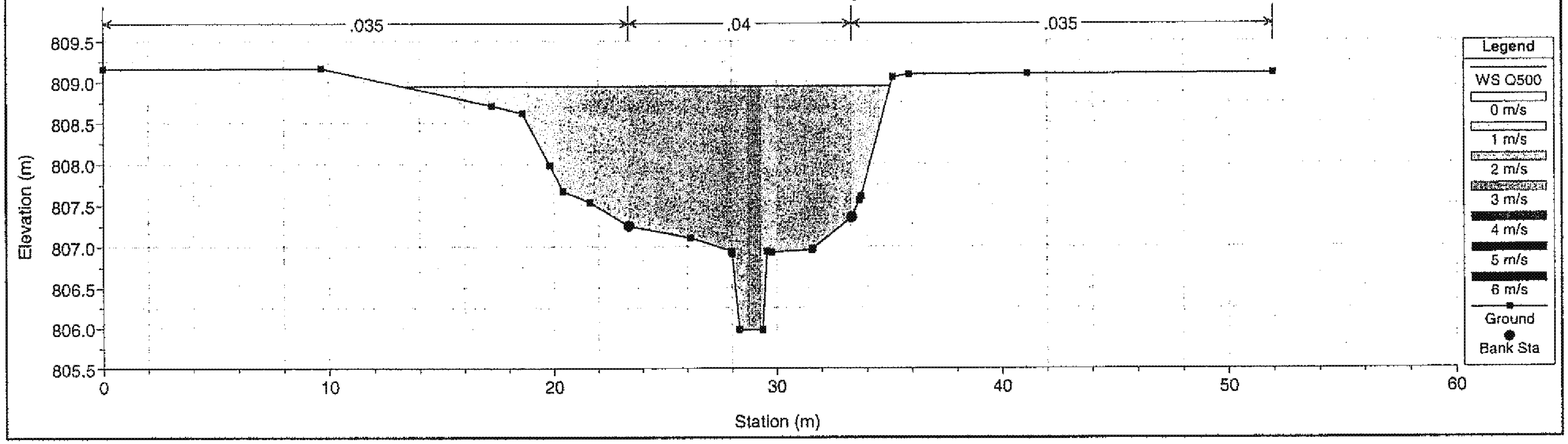
Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10595 XS11

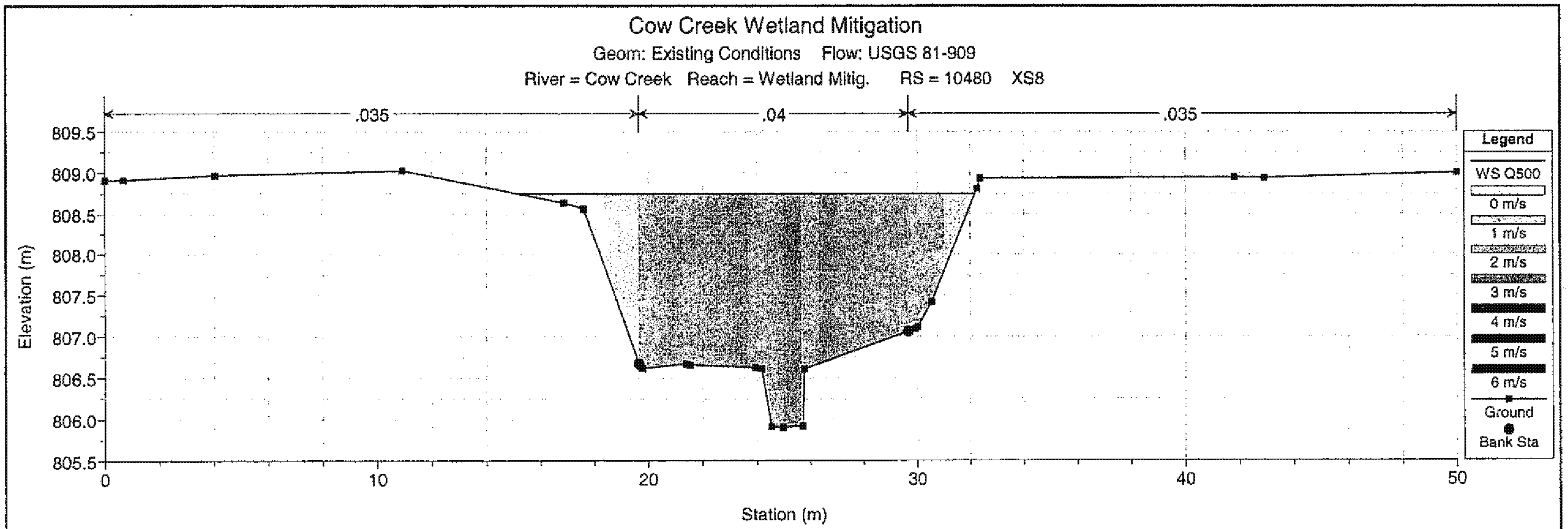


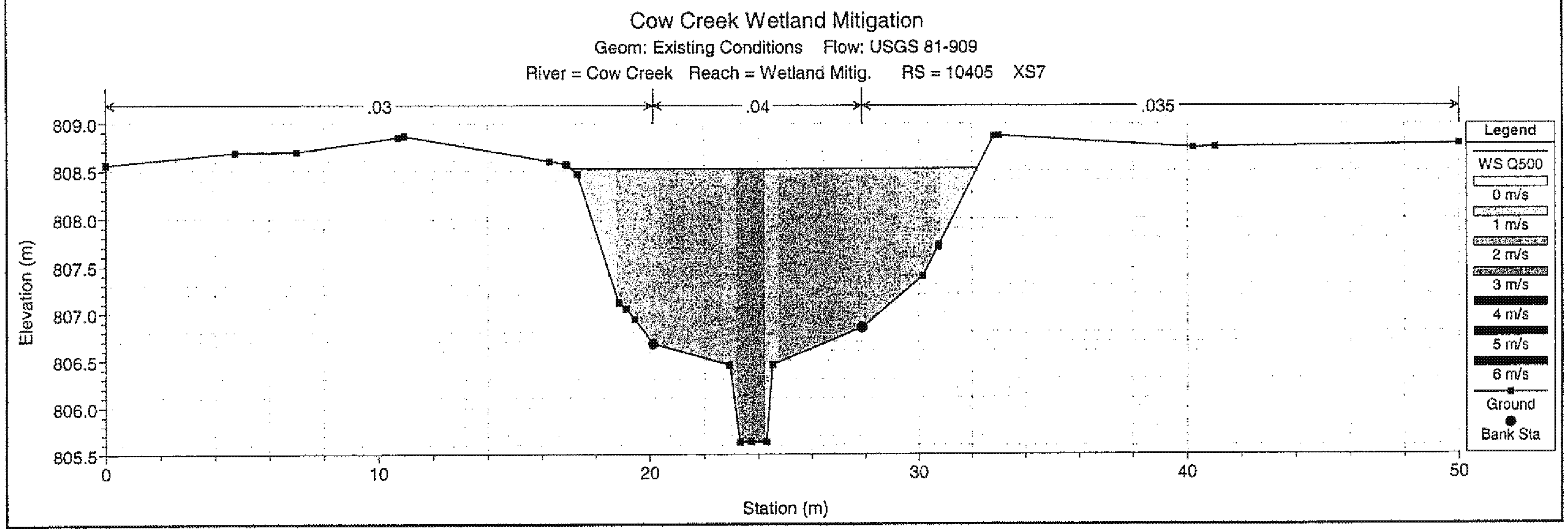
Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10575 XS10



Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10555 XS9



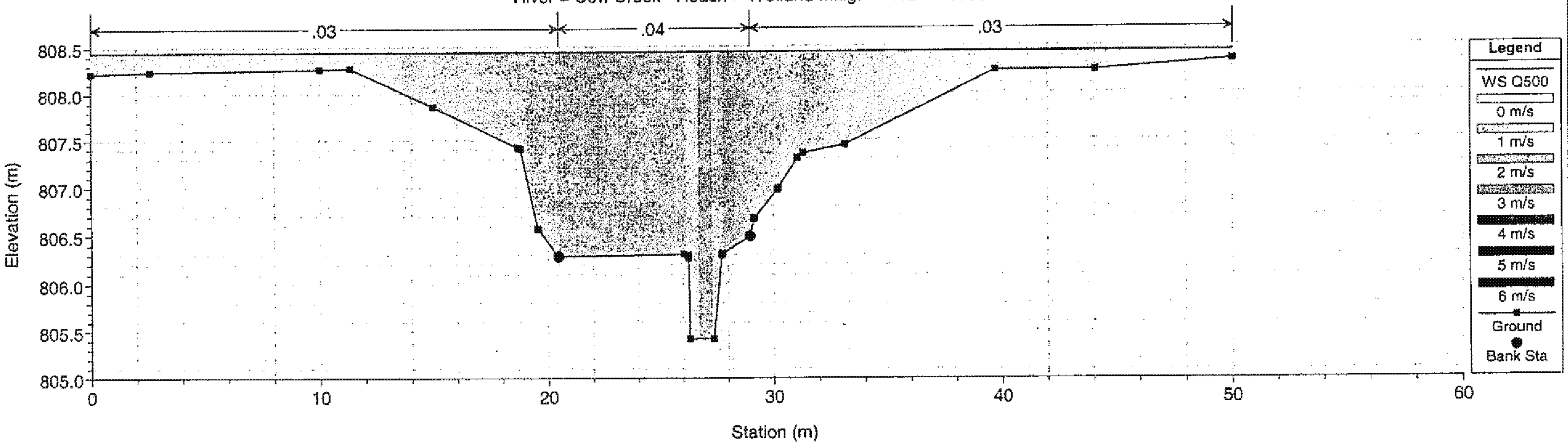

Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10480 XS8
.035
.04
.035
Elevation (m)
809.5
809.0
808.5
808.0
807.5
807.0
806.5
806.0
805.5
0
10
20
30
40
50
Station (m)
Legend
WS Q500
0 m/s
1 m/s
2 m/s
3 m/s
4 m/s
5 m/s
6 m/s
Ground
Bank Sta


Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10405 XS7
.03
.04
.035
Elevation (m)
809.0
808.5
808.0
807.5
807.0
806.5
806.0
805.5
0
10
20
30
40
50
Station (m)
Legend
WS Q500
0 m/s
1 m/s
2 m/s
3 m/s
4 m/s
5 m/s
6 m/s
Ground
Bank Sta

Cow Creek Wetland Mitigation

Geom: Existing Conditions Flow: USGS 81-909

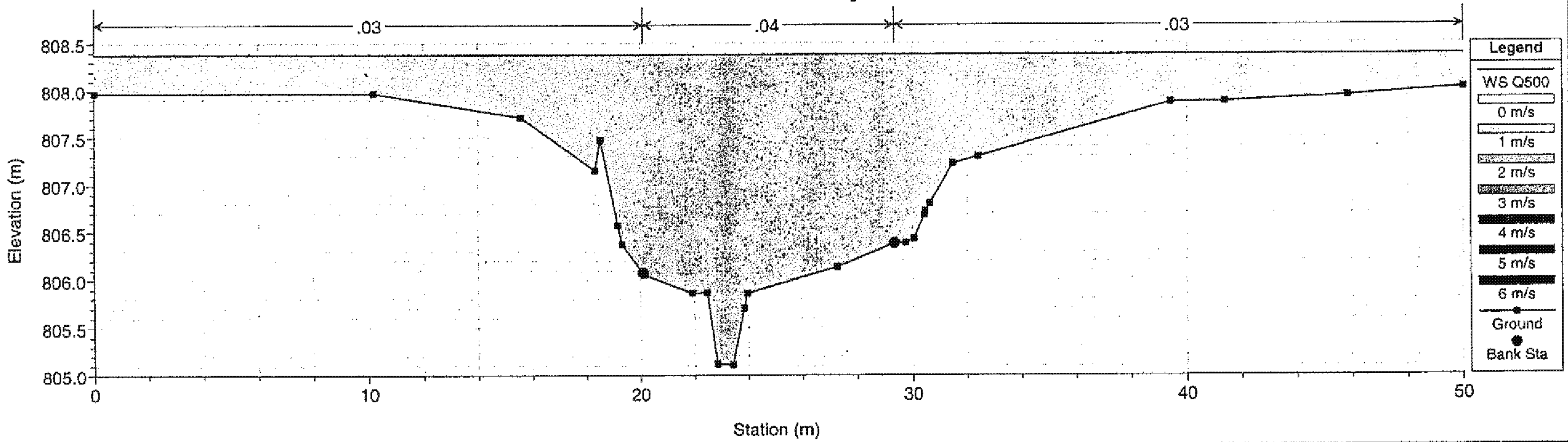
River = Cow Creek Reach = Wetland Mitig. RS = 10330 XS6



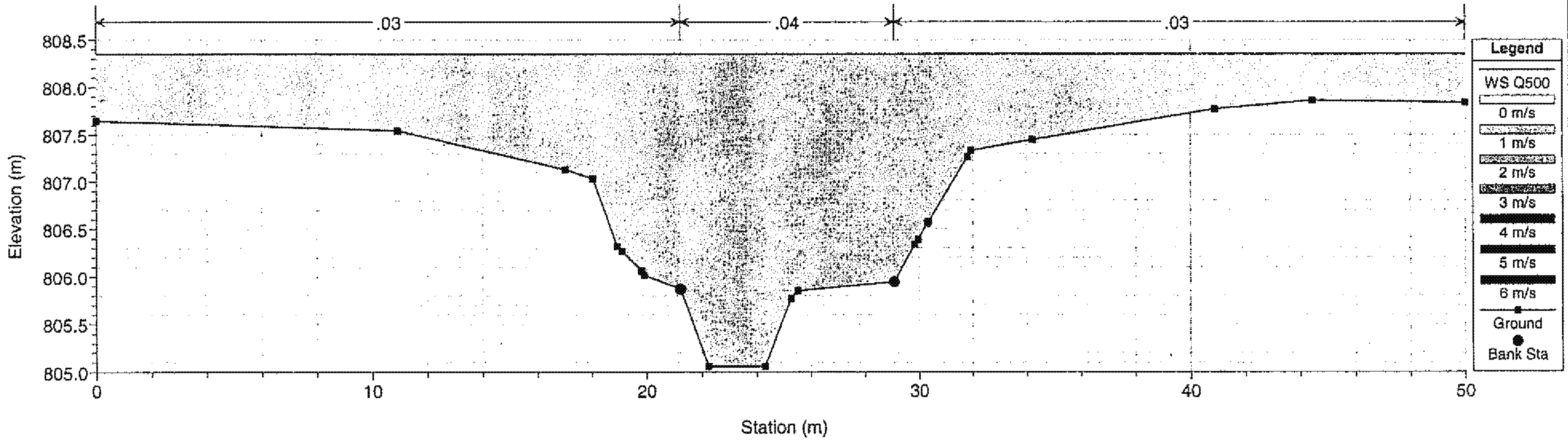
Cow Creek Wetland Mitigation

Geom: Existing Conditions Flow: USGS 81-909

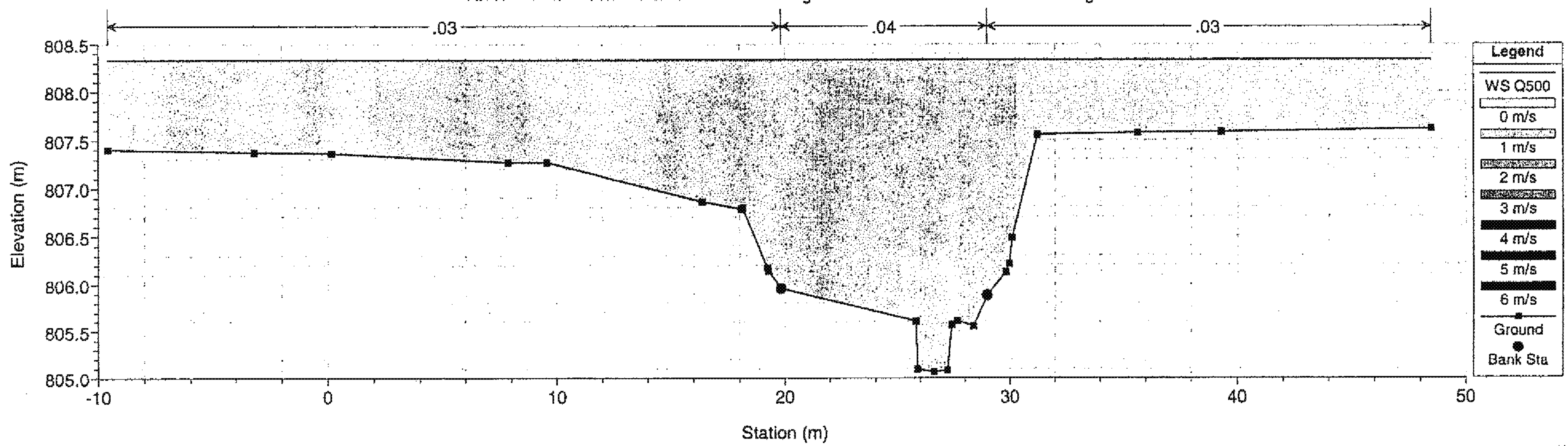
River = Cow Creek Reach = Wetland Mitig. RS = 10240 XS5



Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10160 XS4



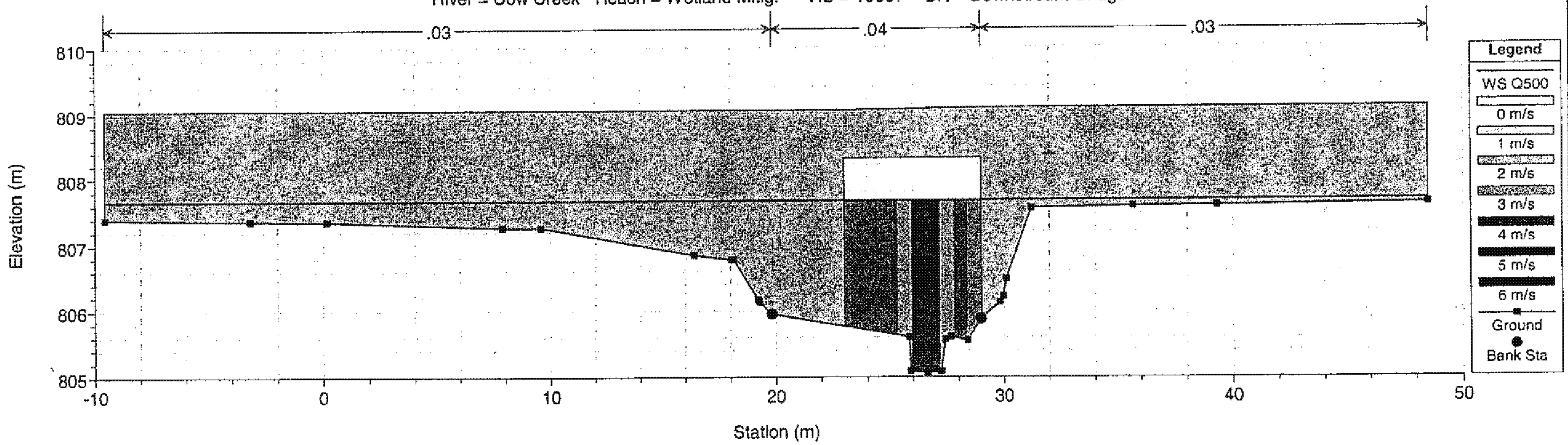
Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10080 XS3 Above Bridge



Cow Creek Wetland Mitigation

Geom: Existing Conditions Flow: USGS 81-909

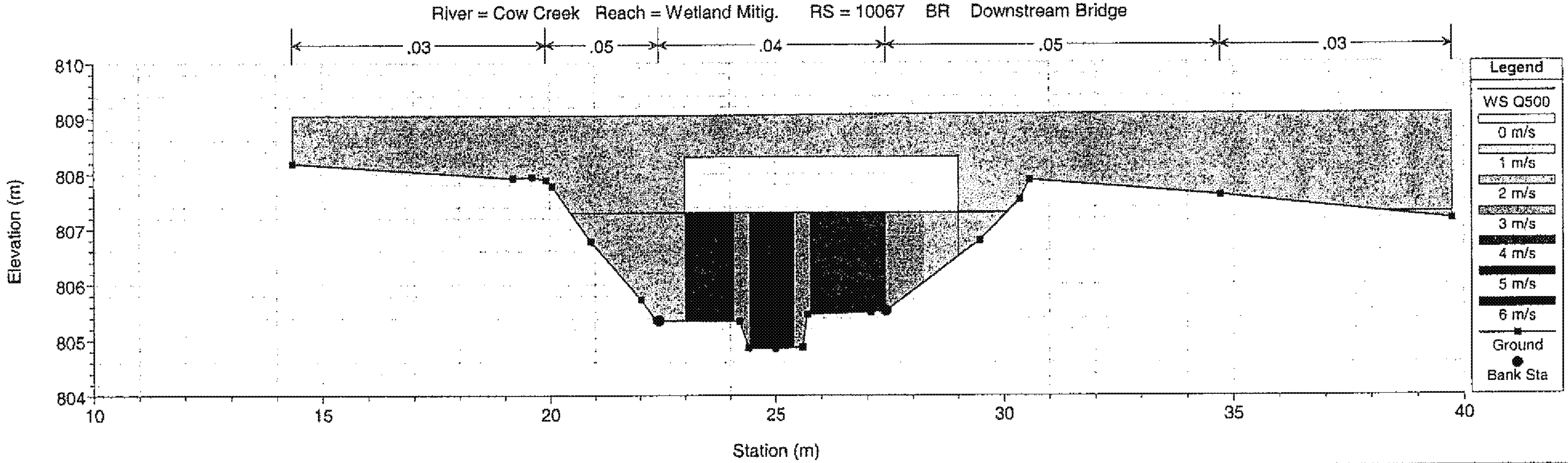
River = Cow Creek Reach = Wetland Mitig. RS = 10067 BR Downstream Bridge

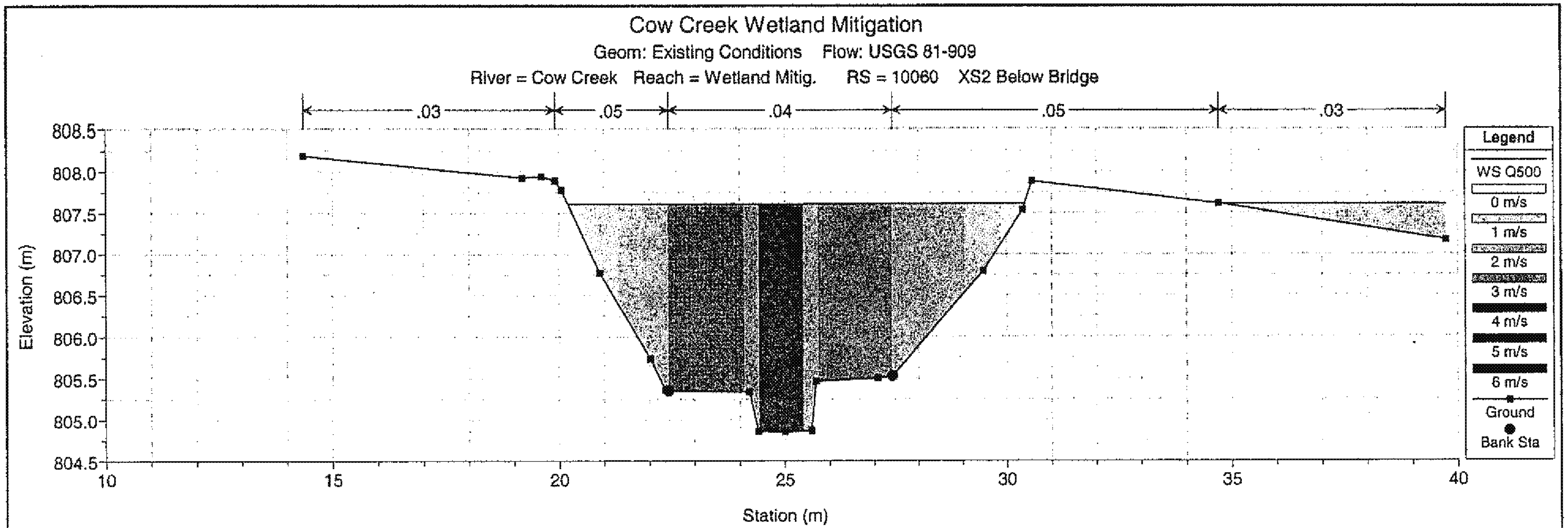


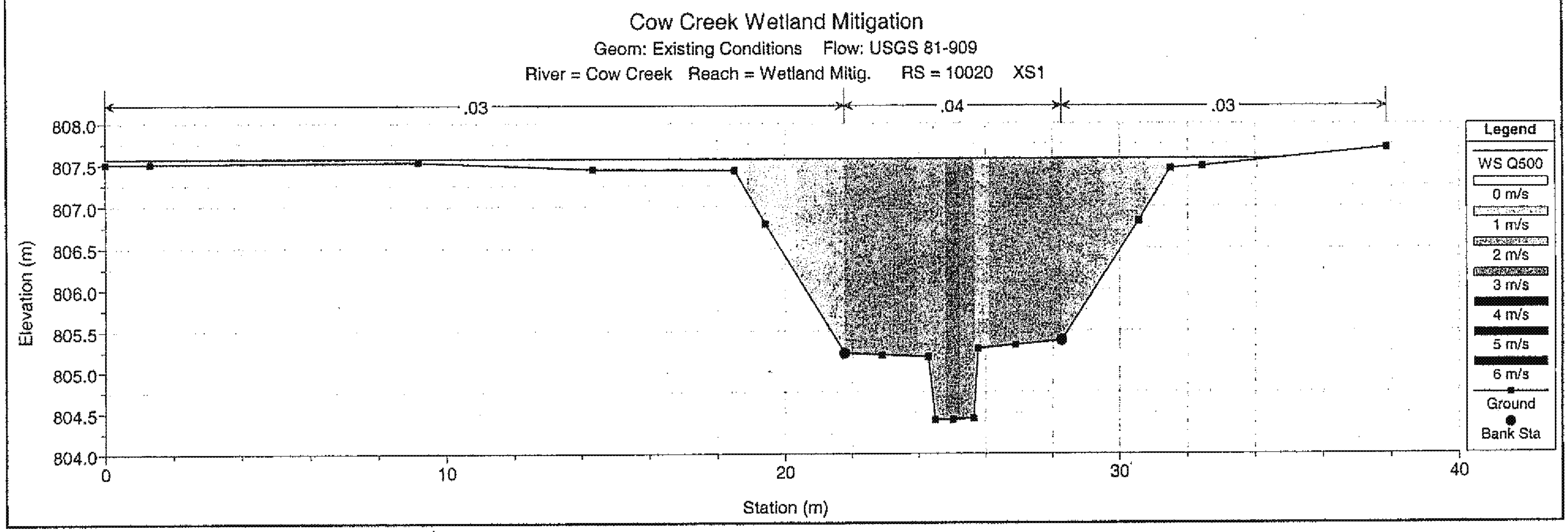
Cow Creek Wetland Mitigation

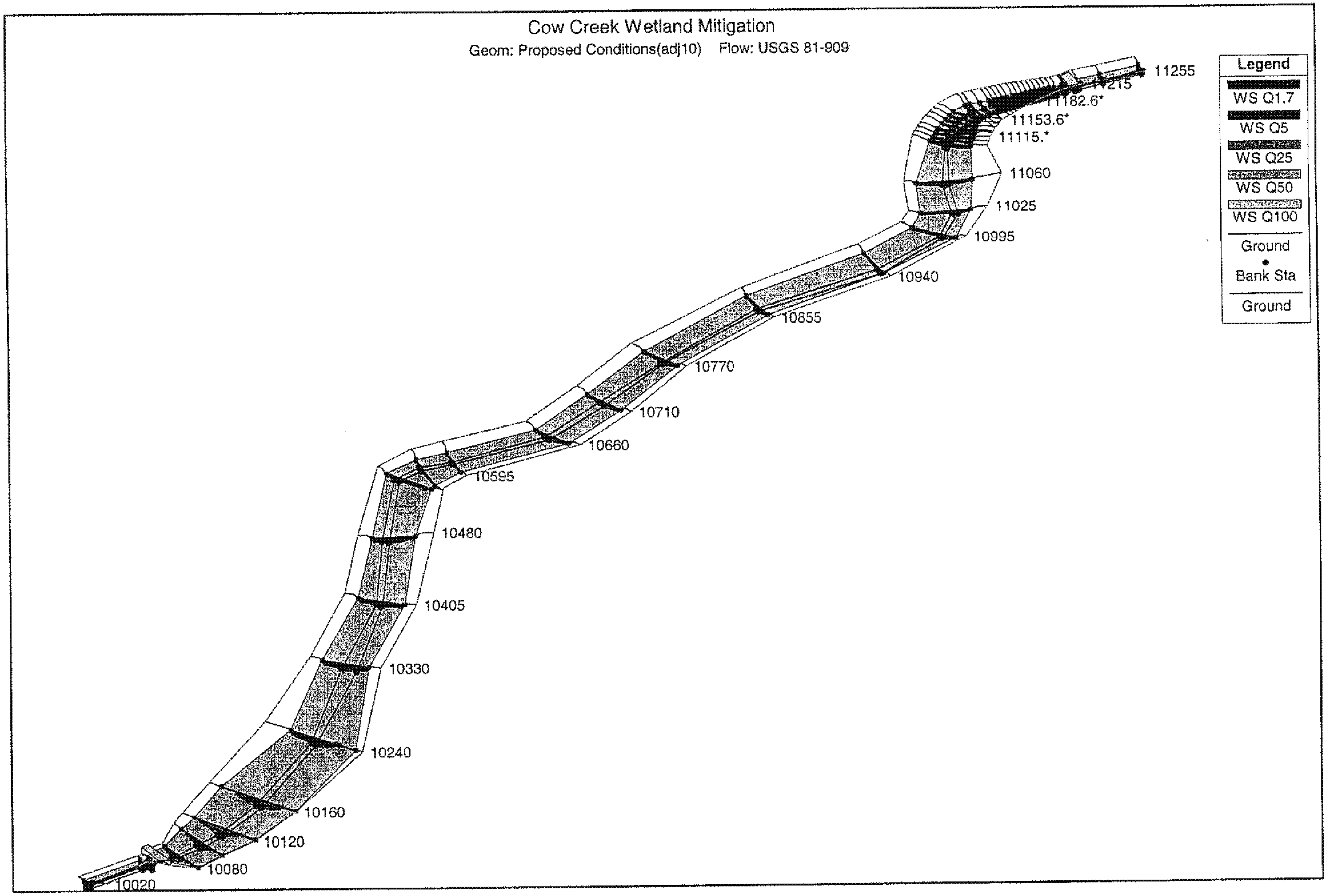
Geom: Existing Conditions Flow: USGS 81-909

River = Cow Creek Reach = Wetland Mitig. RS = 10067 BR Downstream Bridge

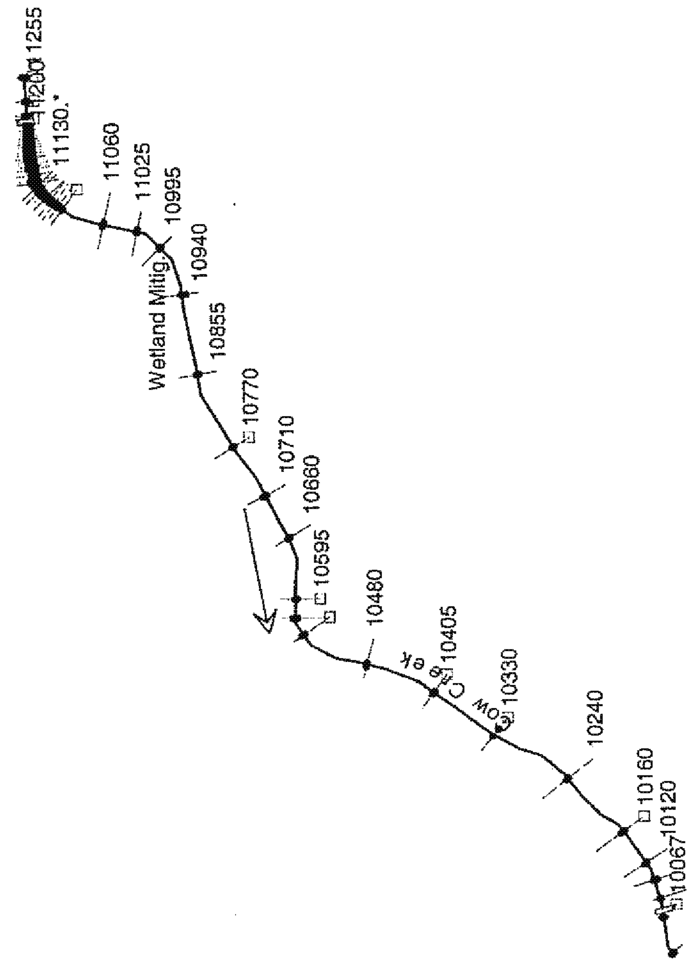



Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10060 XS2 Below Bridge
.03
.05
.04
.05
.03
Elevation (m)
808.5
808.0
807.5
807.0
806.5
806.0
805.5
805.0
804.5
10
15
20
25
30
35
40
Station (m)
Legend
WS Q500
0 m/s
1 m/s
2 m/s
3 m/s
4 m/s
5 m/s
6 m/s
Ground
Bank Sta


Cow Creek Wetland Mitigation
Geom: Existing Conditions Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10020 XS1
.03
.04
.03
Elevation (m)
808.0
807.5
807.0
806.5
806.0
805.5
805.0
804.5
804.0
0
10
20
30
40
Station (m)
Legend
WS Q500
0 m/s
1 m/s
2 m/s
3 m/s
4 m/s
5 m/s
6 m/s
Ground
Bank Sta



Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
11255
11215
11182.6*
11153.6*
11115.*
11060
11025
10995
10940
10855
10770
10710
10660
10595
10480
10405
10330
10240
10160
10120
10080
10020
Legend
WS Q1.7
WS Q5
WS Q25
WS Q50
WS Q100
Ground
Bank Sta
Ground


11255
11200
11130.
11060
11025
10995
10940
Wetland Mitig.
10855
10770
10710
10660
10595
10480
10405
10330
10240
10160
10120
10067

HEC-RAS Plan: Prop10,81 River: Cow Creek Reach: Wetland Mitig.

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Wetland Mitig.	11255	Q1.7	8.50	806.98	808.86	808.43	808.91	0.002894	1.08	8.07	10.46	0.37
Wetland Mitig.	11255	Q5	14.70	806.98	809.12	808.64	809.22	0.003345	1.38	11.04	11.63	0.41
Wetland Mitig.	11255	Q25	23.79	806.98	809.42	808.90	809.56	0.003747	1.70	14.61	12.54	0.45
Wetland Mitig.	11255	Q50	28.09	806.98	809.54	809.00	809.70	0.003850	1.82	16.16	12.91	0.46
Wetland Mitig.	11255	Q100	32.73	806.98	809.67	809.11	809.84	0.003906	1.93	17.79	13.29	0.47
Wetland Mitig.	11255	Q500	44.91	806.98	809.97	809.35	810.19	0.003895	2.15	21.99	14.20	0.49
Wetland Mitig.	11230	Q1.7	8.50	807.28	808.75		808.83	0.004051	1.31	6.85	10.39	0.44
Wetland Mitig.	11230	Q5	14.70	807.28	809.00		809.12	0.004362	1.61	9.69	11.70	0.48
Wetland Mitig.	11230	Q25	23.79	807.28	809.28		809.45	0.004549	1.91	13.15	12.64	0.51
Wetland Mitig.	11230	Q50	28.09	807.28	809.41		809.59	0.004525	2.01	14.71	13.04	0.52
Wetland Mitig.	11230	Q100	32.73	807.28	809.53		809.74	0.004442	2.10	16.39	13.46	0.52
Wetland Mitig.	11230	Q500	44.91	807.28	809.85		810.09	0.004096	2.26	20.82	14.51	0.51
Wetland Mitig.	11215	Q1.7	8.50	807.23	808.71	808.20	808.78	0.002437	1.18	8.51	10.10	0.35
Wetland Mitig.	11215	Q5	14.70	807.23	808.94	808.46	809.06	0.003737	1.63	10.97	11.13	0.44
Wetland Mitig.	11215	Q25	23.79	807.23	809.18	808.74	809.38	0.005387	2.16	13.72	11.91	0.54
Wetland Mitig.	11215	Q50	28.09	807.23	809.28	808.87	809.51	0.006012	2.36	14.91	12.24	0.57
Wetland Mitig.	11215	Q100	32.73	807.23	809.38	808.98	809.65	0.006542	2.55	16.19	12.58	0.60
Wetland Mitig.	11215	Q500	44.91	807.23	809.66	809.25	810.00	0.007035	2.90	19.83	13.21	0.64
Wetland Mitig.	11208		Bridge									
Wetland Mitig.	11205	Q1.7	8.50	807.24	808.69		808.75	0.003593	1.07	8.08	9.81	0.36
Wetland Mitig.	11205	Q5	14.70	807.24	808.91		809.02	0.005100	1.47	10.26	10.37	0.45
Wetland Mitig.	11205	Q25	23.79	807.24	809.12		809.32	0.007233	1.98	12.51	10.60	0.55
Wetland Mitig.	11205	Q50	28.09	807.24	809.20		809.44	0.008177	2.19	13.38	10.63	0.59
Wetland Mitig.	11205	Q100	32.73	807.24	809.29		809.57	0.009108	2.40	14.26	10.67	0.63
Wetland Mitig.	11205	Q500	44.91	807.24	809.49		809.90	0.011023	2.88	16.42	10.75	0.71
Wetland Mitig.	11200	Q1.7	8.50	807.23	808.67		808.73	0.003836	1.08	7.95	9.89	0.37
Wetland Mitig.	11200	Q5	14.70	807.23	808.88		808.99	0.005547	1.50	10.02	10.38	0.47
Wetland Mitig.	11200	Q25	23.79	807.23	809.07		809.26	0.008247	2.04	12.03	10.69	0.58
Wetland Mitig.	11200	Q50	28.09	807.23	809.14		809.40	0.009596	2.28	12.76	10.80	0.63
Wetland Mitig.	11200	Q100	32.73	807.23	809.20		809.52	0.011081	2.53	13.45	10.91	0.69
Wetland Mitig.	11200	Q500	44.91	807.23	809.33		809.82	0.015362	3.16	14.86	11.12	0.82
Wetland Mitig.	11197.1*	Q1.7	8.50	807.27	808.67		808.72	0.002442	1.06	8.11	10.34	0.37
Wetland Mitig.	11197.1*	Q5	14.70	807.27	808.87		808.98	0.003471	1.46	10.27	10.86	0.46
Wetland Mitig.	11197.1*	Q25	23.79	807.27	809.06		809.25	0.005079	1.98	12.37	11.21	0.57
Wetland Mitig.	11197.1*	Q50	28.09	807.27	809.13		809.37	0.005855	2.20	13.15	11.34	0.62
Wetland Mitig.	11197.1*	Q100	32.73	807.27	809.19		809.49	0.006704	2.43	13.89	11.46	0.66
Wetland Mitig.	11197.1*	Q500	44.91	807.27	809.33		809.78	0.009052	3.01	15.46	11.70	0.78
Wetland Mitig.	11194.2*	Q1.7	8.50	807.25	808.66		808.71	0.002272	1.03	8.40	10.81	0.36
Wetland Mitig.	11194.2*	Q5	14.70	807.25	808.86		808.96	0.003220	1.41	10.66	11.36	0.44
Wetland Mitig.	11194.2*	Q25	23.79	807.25	809.06		809.24	0.004696	1.91	12.86	11.75	0.55
Wetland Mitig.	11194.2*	Q50	28.09	807.25	809.12		809.35	0.005403	2.12	13.68	11.90	0.59
Wetland Mitig.	11194.2*	Q100	32.73	807.25	809.19		809.46	0.006169	2.34	14.47	12.03	0.64
Wetland Mitig.	11194.2*	Q500	44.91	807.25	809.33		809.74	0.008244	2.89	16.17	12.32	0.75
Wetland Mitig.	11191.3*	Q1.7	8.50	807.24	808.66		808.71	0.002116	0.99	8.70	11.30	0.35
Wetland Mitig.	11191.3*	Q5	14.70	807.24	808.86		808.95	0.002991	1.36	11.06	11.88	0.43
Wetland Mitig.	11191.3*	Q25	23.79	807.24	809.05		809.22	0.004350	1.84	13.37	12.32	0.53
Wetland Mitig.	11191.3*	Q50	28.09	807.24	809.12		809.33	0.004996	2.04	14.23	12.48	0.57
Wetland Mitig.	11191.3*	Q100	32.73	807.24	809.19		809.44	0.005690	2.26	15.07	12.63	0.62
Wetland Mitig.	11191.3*	Q500	44.91	807.24	809.33		809.71	0.007531	2.77	16.90	12.96	0.72
Wetland Mitig.	11188.4*	Q1.7	8.50	807.22	808.65		808.70	0.001975	0.96	9.01	11.80	0.34
Wetland Mitig.	11188.4*	Q5	14.70	807.22	808.86		808.94	0.002786	1.32	11.47	12.41	0.41
Wetland Mitig.	11188.4*	Q25	23.79	807.22	809.05		809.20	0.004041	1.77	13.89	12.90	0.51
Wetland Mitig.	11188.4*	Q50	28.09	807.22	809.12		809.31	0.004634	1.97	14.80	13.08	0.55
Wetland Mitig.	11188.4*	Q100	32.73	807.22	809.18		809.42	0.005265	2.17	15.68	13.25	0.59
Wetland Mitig.	11188.4*	Q500	44.91	807.22	809.33		809.68	0.006904	2.66	17.65	13.60	0.69
Wetland Mitig.	11185.5*	Q1.7	8.50	807.21	808.65		808.69	0.001850	0.93	9.32	12.32	0.32
Wetland Mitig.	11185.5*	Q5	14.70	807.21	808.85		808.93	0.002603	1.27	11.89	12.97	0.40
Wetland Mitig.	11185.5*	Q25	23.79	807.21	809.04		809.19	0.003767	1.72	14.41	13.51	0.49

HEC-RAS Plan: Prop10,81 River: Cow Creek Reach: Wetland Mitig. (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Wetland Mitig.	11185.5*	Q50	28.09	807.21	809.11		809.29	0.004311	1.90	15.37	13.71	0.53
Wetland Mitig.	11185.5*	Q100	32.73	807.21	809.18		809.40	0.004889	2.10	16.31	13.91	0.57
Wetland Mitig.	11185.5*	Q500	44.91	807.21	809.33		809.65	0.006359	2.56	18.41	14.27	0.67
Wetland Mitig.	11182.6*	Q1.7	8.50	807.19	808.65		808.69	0.001732	0.90	9.64	12.86	0.31
Wetland Mitig.	11182.6*	Q5	14.70	807.19	808.85		808.92	0.002433	1.23	12.32	13.55	0.39
Wetland Mitig.	11182.6*	Q25	23.79	807.19	809.04		809.18	0.003513	1.66	14.96	14.16	0.48
Wetland Mitig.	11182.6*	Q50	28.09	807.19	809.11		809.28	0.004014	1.84	15.97	14.38	0.52
Wetland Mitig.	11182.6*	Q100	32.73	807.19	809.18		809.38	0.004542	2.03	16.96	14.59	0.55
Wetland Mitig.	11182.6*	Q500	44.91	807.19	809.33		809.63	0.005879	2.47	19.20	15.12	0.64
Wetland Mitig.	11179.7*	Q1.7	8.50	807.18	808.64		808.68	0.001626	0.87	9.97	13.43	0.31
Wetland Mitig.	11179.7*	Q5	14.70	807.18	808.85		808.92	0.002279	1.19	12.76	14.16	0.37
Wetland Mitig.	11179.7*	Q25	23.79	807.18	809.04		809.16	0.003284	1.60	15.53	14.83	0.46
Wetland Mitig.	11179.7*	Q50	28.09	807.18	809.11		809.26	0.003747	1.78	16.59	15.08	0.50
Wetland Mitig.	11179.7*	Q100	32.73	807.18	809.18		809.36	0.004230	1.96	17.63	15.28	0.53
Wetland Mitig.	11179.7*	Q500	44.91	807.18	809.33		809.60	0.005448	2.38	20.03	16.03	0.62
Wetland Mitig.	11176.8*	Q1.7	8.50	807.17	808.64		808.68	0.001529	0.85	10.31	14.00	0.30
Wetland Mitig.	11176.8*	Q5	14.70	807.17	808.84		808.91	0.002139	1.16	13.22	14.80	0.36
Wetland Mitig.	11176.8*	Q25	23.79	807.17	809.03		809.15	0.003075	1.55	16.12	15.56	0.45
Wetland Mitig.	11176.8*	Q50	28.09	807.17	809.10		809.25	0.003502	1.72	17.23	15.82	0.48
Wetland Mitig.	11176.8*	Q100	32.73	807.17	809.17		809.35	0.003954	1.89	18.33	16.19	0.52
Wetland Mitig.	11176.8*	Q500	44.91	807.17	809.33		809.58	0.005050	2.30	20.91	17.03	0.60
Wetland Mitig.	11173.9*	Q1.7	8.50	807.15	808.64		808.67	0.001437	0.82	10.66	14.59	0.29
Wetland Mitig.	11173.9*	Q5	14.70	807.15	808.84		808.90	0.002008	1.12	13.70	15.49	0.35
Wetland Mitig.	11173.9*	Q25	23.79	807.15	809.03		809.14	0.002879	1.50	16.73	16.33	0.43
Wetland Mitig.	11173.9*	Q50	28.09	807.15	809.10		809.24	0.003280	1.67	17.91	16.76	0.47
Wetland Mitig.	11173.9*	Q100	32.73	807.15	809.17		809.33	0.003694	1.83	19.09	17.18	0.50
Wetland Mitig.	11173.9*	Q500	44.91	807.15	809.32		809.56	0.004677	2.21	21.87	18.13	0.57
Wetland Mitig.	11171.0*	Q1.7	8.50	807.14	808.64		808.67	0.001356	0.80	11.03	15.22	0.28
Wetland Mitig.	11171.0*	Q5	14.70	807.14	808.84		808.90	0.001892	1.09	14.19	16.23	0.34
Wetland Mitig.	11171.0*	Q25	23.79	807.14	809.03		809.13	0.002714	1.46	17.38	17.32	0.42
Wetland Mitig.	11171.0*	Q50	28.09	807.14	809.10		809.23	0.003086	1.61	18.63	17.80	0.45
Wetland Mitig.	11171.0*	Q100	32.73	807.14	809.17		809.32	0.003467	1.77	19.89	18.26	0.48
Wetland Mitig.	11171.0*	Q500	44.91	807.14	809.33		809.55	0.004361	2.14	22.88	19.32	0.55
Wetland Mitig.	11168.1*	Q1.7	8.50	807.12	808.63		808.66	0.001278	0.77	11.41	15.90	0.27
Wetland Mitig.	11168.1*	Q5	14.70	807.12	808.83		808.89	0.001779	1.05	14.72	17.04	0.33
Wetland Mitig.	11168.1*	Q25	23.79	807.12	809.02		809.12	0.002546	1.41	18.09	18.42	0.41
Wetland Mitig.	11168.1*	Q50	28.09	807.12	809.10		809.21	0.002886	1.56	19.43	18.95	0.44
Wetland Mitig.	11168.1*	Q100	32.73	807.12	809.17		809.31	0.003233	1.71	20.78	19.47	0.47
Wetland Mitig.	11168.1*	Q500	44.91	807.12	809.33		809.53	0.004040	2.06	24.01	20.72	0.53
Wetland Mitig.	11165.2*	Q1.7	8.50	807.11	808.63		808.66	0.001203	0.75	11.81	16.64	0.26
Wetland Mitig.	11165.2*	Q5	14.70	807.11	808.83		808.88	0.001674	1.02	15.28	18.06	0.32
Wetland Mitig.	11165.2*	Q25	23.79	807.11	809.02		809.11	0.002381	1.37	18.87	19.63	0.39
Wetland Mitig.	11165.2*	Q50	28.09	807.11	809.09		809.20	0.002693	1.51	20.31	20.22	0.42
Wetland Mitig.	11165.2*	Q100	32.73	807.11	809.16		809.29	0.003007	1.65	21.76	20.80	0.45
Wetland Mitig.	11165.2*	Q500	44.91	807.11	809.33		809.51	0.003781	1.99	25.27	23.08	0.52
Wetland Mitig.	11162.3*	Q1.7	8.50	807.09	808.63		808.65	0.001134	0.73	12.23	17.46	0.26
Wetland Mitig.	11162.3*	Q5	14.70	807.09	808.83		808.88	0.001575	0.99	15.90	19.23	0.31
Wetland Mitig.	11162.3*	Q25	23.79	807.09	809.02		809.10	0.002224	1.32	19.74	20.98	0.38
Wetland Mitig.	11162.3*	Q50	28.09	807.09	809.09		809.19	0.002508	1.46	21.29	21.65	0.41
Wetland Mitig.	11162.3*	Q100	32.73	807.09	809.16		809.28	0.002808	1.60	22.84	22.60	0.44
Wetland Mitig.	11162.3*	Q500	44.91	807.09	809.33		809.50	0.003503	1.92	26.79	25.87	0.50
Wetland Mitig.	11159.4*	Q1.7	8.50	807.08	808.63		808.65	0.001069	0.71	12.68	18.40	0.25
Wetland Mitig.	11159.4*	Q5	14.70	807.08	808.83		808.87	0.001477	0.96	16.59	20.55	0.30
Wetland Mitig.	11159.4*	Q25	23.79	807.08	809.02		809.10	0.002071	1.27	20.72	22.52	0.37
Wetland Mitig.	11159.4*	Q50	28.09	807.08	809.09		809.18	0.002343	1.41	22.39	23.73	0.39
Wetland Mitig.	11159.4*	Q100	32.73	807.08	809.16		809.27	0.002616	1.54	24.12	25.09	0.42
Wetland Mitig.	11159.4*	Q500	44.91	807.08	809.33		809.48	0.003195	1.84	28.60	28.65	0.47
Wetland Mitig.	11153.6*	Q1.7	8.50	807.05	808.61		808.64	0.001375	0.83	10.89	18.48	0.28

HEC-RAS Plan: Prop10,81 River: Cow Creek Reach: Wetland Mitig. (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Wetland Mitig.	11153.6*	Q5	14.70	807.05	808.80		808.86	0.001978	1.14	14.95	23.39	0.35
Wetland Mitig.	11153.6*	Q25	23.79	807.05	808.98		809.06	0.002774	1.49	19.44	26.69	0.42
Wetland Mitig.	11153.6*	Q50	28.09	807.05	809.05		809.17	0.003099	1.63	21.34	28.11	0.45
Wetland Mitig.	11153.6*	Q100	32.73	807.05	809.12		809.25	0.003399	1.77	23.33	29.53	0.47
Wetland Mitig.	11153.6*	Q500	44.91	807.05	809.29		809.46	0.003918	2.04	28.62	33.01	0.52
Wetland Mitig.	11147.8*	Q1.7	8.50	807.02	808.61		808.63	0.000843	0.62	15.14	24.80	0.22
Wetland Mitig.	11147.8*	Q5	14.70	807.02	808.81		808.84	0.001133	0.83	20.39	28.60	0.26
Wetland Mitig.	11147.8*	Q25	23.79	807.02	809.00		809.05	0.001541	1.09	26.17	32.36	0.32
Wetland Mitig.	11147.8*	Q50	28.09	807.02	809.07		809.14	0.001705	1.19	28.61	33.83	0.34
Wetland Mitig.	11147.8*	Q100	32.73	807.02	809.15		809.22	0.001856	1.29	31.15	35.29	0.35
Wetland Mitig.	11147.8*	Q500	44.91	807.02	809.33		809.42	0.002130	1.50	37.76	38.83	0.39
Wetland Mitig.	11145	Q1.7	8.50	807.01	808.61		808.63	0.000776	0.60	16.13	27.32	0.21
Wetland Mitig.	11145	Q5	14.70	807.01	808.81		808.84	0.001026	0.79	21.91	31.18	0.25
Wetland Mitig.	11145	Q25	23.79	807.01	809.00		809.05	0.001381	1.03	28.21	34.91	0.30
Wetland Mitig.	11145	Q50	28.09	807.01	809.07		809.13	0.001522	1.13	30.85	36.36	0.32
Wetland Mitig.	11145	Q100	32.73	807.01	809.15		809.21	0.001653	1.22	33.61	37.82	0.33
Wetland Mitig.	11145	Q500	44.91	807.01	809.33		809.41	0.001889	1.41	40.72	41.33	0.36
Wetland Mitig.	11140.*	Q1.7	8.50	807.04	808.59		808.62	0.001151	0.80	12.01	17.82	0.26
Wetland Mitig.	11140.*	Q5	14.70	807.04	808.78		808.83	0.001715	1.09	16.87	30.98	0.33
Wetland Mitig.	11140.*	Q25	23.79	807.04	808.95		809.03	0.002371	1.41	22.60	34.67	0.39
Wetland Mitig.	11140.*	Q50	28.09	807.04	809.02		809.12	0.002620	1.53	25.02	36.16	0.42
Wetland Mitig.	11140.*	Q100	32.73	807.04	809.09		809.20	0.002834	1.65	27.58	37.65	0.44
Wetland Mitig.	11140.*	Q500	44.91	807.04	809.26		809.39	0.003137	1.87	34.44	41.35	0.47
Wetland Mitig.	11135.*	Q1.7	8.50	807.07	808.59		808.62	0.000890	0.67	15.29	27.34	0.23
Wetland Mitig.	11135.*	Q5	14.70	807.07	808.78		808.82	0.001224	0.89	20.83	31.86	0.28
Wetland Mitig.	11135.*	Q25	23.79	807.07	808.96		809.02	0.001689	1.16	26.90	36.14	0.33
Wetland Mitig.	11135.*	Q50	28.09	807.07	809.03		809.09	0.001872	1.27	29.47	37.75	0.35
Wetland Mitig.	11135.*	Q100	32.73	807.07	809.10		809.17	0.002036	1.37	32.18	39.38	0.37
Wetland Mitig.	11135.*	Q500	44.91	807.07	809.27		809.37	0.002300	1.58	39.41	43.48	0.40
Wetland Mitig.	11130.*	Q1.7	8.50	807.10	808.59		808.61	0.000971	0.72	14.95	27.94	0.24
Wetland Mitig.	11130.*	Q5	14.70	807.10	808.77		808.81	0.001334	0.95	20.59	33.04	0.29
Wetland Mitig.	11130.*	Q25	23.79	807.10	808.95		809.01	0.001826	1.23	26.79	37.49	0.35
Wetland Mitig.	11130.*	Q50	28.09	807.10	809.02		809.09	0.002019	1.34	29.42	39.23	0.37
Wetland Mitig.	11130.*	Q100	32.73	807.10	809.09		809.16	0.002189	1.44	32.21	41.03	0.39
Wetland Mitig.	11130.*	Q500	44.91	807.10	809.26		809.36	0.002440	1.64	39.77	45.56	0.42
Wetland Mitig.	11125.*	Q1.7	8.50	807.13	808.58		808.61	0.001082	0.77	14.69	29.23	0.25
Wetland Mitig.	11125.*	Q5	14.70	807.13	808.76		808.80	0.001454	1.01	20.56	34.56	0.30
Wetland Mitig.	11125.*	Q25	23.79	807.13	808.94		809.00	0.001967	1.29	26.98	39.44	0.36
Wetland Mitig.	11125.*	Q50	28.09	807.13	809.01		809.07	0.002162	1.40	29.73	41.38	0.38
Wetland Mitig.	11125.*	Q100	32.73	807.13	809.07		809.15	0.002329	1.50	32.67	43.36	0.40
Wetland Mitig.	11125.*	Q500	44.91	807.13	809.25		809.34	0.002550	1.70	40.75	48.65	0.43
Wetland Mitig.	11120.*	Q1.7	8.50	807.16	808.57		808.60	0.001217	0.84	14.65	31.31	0.27
Wetland Mitig.	11120.*	Q5	14.70	807.16	808.75		808.80	0.001574	1.07	20.86	36.76	0.32
Wetland Mitig.	11120.*	Q25	23.79	807.16	808.93		808.99	0.002080	1.35	27.69	42.23	0.37
Wetland Mitig.	11120.*	Q50	28.09	807.16	808.99		809.06	0.002274	1.46	30.63	44.60	0.39
Wetland Mitig.	11120.*	Q100	32.73	807.16	809.06		809.14	0.002406	1.55	33.80	46.36	0.41
Wetland Mitig.	11120.*	Q500	44.91	807.16	809.24		809.33	0.002534	1.71	42.42	50.84	0.43
Wetland Mitig.	11115.*	Q1.7	8.50	807.19	808.53		808.59	0.002488	1.14	10.43	27.33	0.37
Wetland Mitig.	11115.*	Q5	14.70	807.19	808.71		808.78	0.003074	1.42	16.29	38.63	0.43
Wetland Mitig.	11115.*	Q25	23.79	807.19	808.88		808.97	0.003521	1.67	23.49	44.00	0.47
Wetland Mitig.	11115.*	Q50	28.09	807.19	808.95		809.05	0.003597	1.75	26.65	45.72	0.48
Wetland Mitig.	11115.*	Q100	32.73	807.19	809.02		809.12	0.003617	1.82	30.04	47.49	0.48
Wetland Mitig.	11115.*	Q500	44.91	807.19	809.21		809.31	0.003405	1.92	39.35	52.05	0.48
Wetland Mitig.	11110.*	Q1.7	8.50	807.22	808.52		808.58	0.002649	1.26	10.17	20.37	0.40
Wetland Mitig.	11110.*	Q5	14.70	807.22	808.65		808.76	0.004678	1.81	14.06	36.86	0.54
Wetland Mitig.	11110.*	Q25	23.79	807.22	808.83		808.95	0.004772	2.02	21.67	44.09	0.56
Wetland Mitig.	11110.*	Q50	28.09	807.22	808.91		809.02	0.004616	2.06	25.17	46.01	0.55
Wetland Mitig.	11110.*	Q100	32.73	807.22	808.99		809.10	0.004437	2.10	28.88	47.95	0.55
Wetland Mitig.	11110.*	Q500	44.91	807.22	809.19		809.30	0.003833	2.12	39.00	52.89	0.52

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Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Wetland Mitig.	11105	Q1.7	8.50	807.25	808.53		808.56	0.001548	0.98	16.77	39.50	0.30
Wetland Mitig.	11105	Q5	14.70	807.25	808.69		808.72	0.001889	1.18	23.24	43.08	0.34
Wetland Mitig.	11105	Q25	23.79	807.25	808.87		808.91	0.002158	1.38	31.35	47.33	0.37
Wetland Mitig.	11105	Q50	28.09	807.25	808.94		808.99	0.002228	1.45	34.92	49.09	0.38
Wetland Mitig.	11105	Q100	32.73	807.25	809.02		809.07	0.002274	1.51	38.70	50.88	0.38
Wetland Mitig.	11105	Q500	44.91	807.25	809.21		809.27	0.002230	1.62	48.95	55.45	0.39
Wetland Mitig.	11060	Q1.7	8.50	807.08	808.50		808.51	0.000666	0.57	24.55	57.67	0.19
Wetland Mitig.	11060	Q5	14.70	807.08	808.65		808.66	0.000841	0.71	33.42	61.26	0.22
Wetland Mitig.	11060	Q25	23.79	807.08	808.82		808.84	0.000979	0.85	44.42	65.22	0.25
Wetland Mitig.	11060	Q50	28.09	807.08	808.89		808.92	0.001014	0.90	49.25	66.80	0.25
Wetland Mitig.	11060	Q100	32.73	807.08	808.97		808.99	0.001035	0.95	54.33	68.25	0.26
Wetland Mitig.	11060	Q500	44.91	807.08	809.17		809.19	0.001011	1.02	68.08	72.02	0.26
Wetland Mitig.	11025	Q1.7	8.50	807.15	808.42		808.46	0.003747	1.01	12.74	49.13	0.38
Wetland Mitig.	11025	Q5	14.70	807.15	808.57		808.61	0.003506	1.10	20.40	53.91	0.38
Wetland Mitig.	11025	Q25	23.79	807.15	808.74		808.79	0.003101	1.18	30.16	57.60	0.37
Wetland Mitig.	11025	Q50	28.09	807.15	808.82		808.86	0.002944	1.20	34.50	59.16	0.37
Wetland Mitig.	11025	Q100	32.73	807.15	808.90		808.94	0.002785	1.22	39.11	60.78	0.36
Wetland Mitig.	11025	Q500	44.91	807.15	809.10		809.14	0.002315	1.24	51.98	65.50	0.34
Wetland Mitig.	10995	Q1.7	8.50	807.01	808.34		808.36	0.002593	0.78	16.12	49.78	0.30
Wetland Mitig.	10995	Q5	14.70	807.01	808.49		808.52	0.002439	0.87	24.01	52.55	0.30
Wetland Mitig.	10995	Q25	23.79	807.01	808.68		808.70	0.002282	0.95	33.91	55.76	0.30
Wetland Mitig.	10995	Q50	28.09	807.01	808.75		808.78	0.002217	0.98	38.26	57.12	0.30
Wetland Mitig.	10995	Q100	32.73	807.01	808.83		808.87	0.002141	1.01	42.88	58.53	0.29
Wetland Mitig.	10995	Q500	44.91	807.01	809.05		809.08	0.001842	1.05	55.80	62.29	0.28
Wetland Mitig.	10940	Q1.7	8.50	806.96	808.16		808.20	0.003373	0.97	12.37	41.38	0.41
Wetland Mitig.	10940	Q5	14.70	806.96	808.34		808.38	0.002655	1.03	20.59	47.47	0.38
Wetland Mitig.	10940	Q25	23.79	806.96	808.54		808.58	0.002288	1.12	30.31	50.34	0.37
Wetland Mitig.	10940	Q50	28.09	806.96	808.62		808.66	0.002194	1.16	34.46	51.51	0.37
Wetland Mitig.	10940	Q100	32.73	806.96	808.71		808.75	0.002091	1.20	38.89	52.74	0.36
Wetland Mitig.	10940	Q500	44.91	806.96	808.94		808.99	0.001718	1.23	51.60	56.11	0.34
Wetland Mitig.	10855	Q1.7	8.50	806.94	808.03		808.04	0.001024	0.65	20.25	45.13	0.24
Wetland Mitig.	10855	Q5	14.70	806.94	808.22		808.24	0.001055	0.77	29.06	47.98	0.25
Wetland Mitig.	10855	Q25	23.79	806.94	808.42		808.44	0.001168	0.91	38.76	50.55	0.27
Wetland Mitig.	10855	Q50	28.09	806.94	808.50		808.52	0.001203	0.97	42.91	51.61	0.28
Wetland Mitig.	10855	Q100	32.73	806.94	808.59		808.61	0.001211	1.02	47.43	52.74	0.28
Wetland Mitig.	10855	Q500	44.91	806.94	808.84		808.87	0.001079	1.08	61.07	56.01	0.28
Wetland Mitig.	10770	Q1.7	8.50	806.59	807.91		807.93	0.001796	0.91	15.54	36.03	0.31
Wetland Mitig.	10770	Q5	14.70	806.59	808.08		808.11	0.002055	1.10	22.96	47.24	0.34
Wetland Mitig.	10770	Q25	23.79	806.59	808.27		808.31	0.002068	1.23	32.18	49.99	0.35
Wetland Mitig.	10770	Q50	28.09	806.59	808.35		808.39	0.002049	1.28	36.22	51.15	0.35
Wetland Mitig.	10770	Q100	32.73	806.59	808.44		808.48	0.001958	1.30	40.88	52.45	0.35
Wetland Mitig.	10770	Q500	44.91	806.59	808.72		808.76	0.001470	1.27	56.09	56.50	0.31
Wetland Mitig.	10710	Q1.7	8.50	806.61	807.82		807.83	0.001464	0.65	17.97	48.76	0.26
Wetland Mitig.	10710	Q5	14.70	806.61	807.99		808.01	0.001462	0.76	26.51	50.92	0.28
Wetland Mitig.	10710	Q25	23.79	806.61	808.18		808.20	0.001521	0.90	36.26	53.29	0.29
Wetland Mitig.	10710	Q50	28.09	806.61	808.26		808.28	0.001516	0.95	40.60	54.31	0.30
Wetland Mitig.	10710	Q100	32.73	806.61	808.35		808.38	0.001436	0.98	45.81	55.50	0.29
Wetland Mitig.	10710	Q500	44.91	806.61	808.66		808.68	0.001031	0.97	63.33	59.36	0.26
Wetland Mitig.	10660	Q1.7	8.50	806.35	807.73		807.75	0.001593	0.75	16.95	42.14	0.28
Wetland Mitig.	10660	Q5	14.70	806.35	807.90		807.92	0.001746	0.90	24.41	46.53	0.30
Wetland Mitig.	10660	Q25	23.79	806.35	808.08		808.11	0.001869	1.05	33.09	49.14	0.32
Wetland Mitig.	10660	Q50	28.09	806.35	808.16		808.19	0.001858	1.10	37.12	50.30	0.33
Wetland Mitig.	10660	Q100	32.73	806.35	808.26		808.30	0.001718	1.12	42.28	51.75	0.32
Wetland Mitig.	10660	Q500	44.91	806.35	808.59		808.63	0.001137	1.07	60.38	56.55	0.27
Wetland Mitig.	10595	Q1.7	8.50	806.22	807.53		807.58	0.004695	1.23	11.13	35.24	0.46
Wetland Mitig.	10595	Q5	14.70	806.22	807.69		807.74	0.004579	1.38	17.13	40.63	0.47
Wetland Mitig.	10595	Q25	23.79	806.22	807.86		807.93	0.004422	1.53	24.77	46.05	0.47
Wetland Mitig.	10595	Q50	28.09	806.22	807.97		808.02	0.003662	1.48	29.62	47.53	0.44

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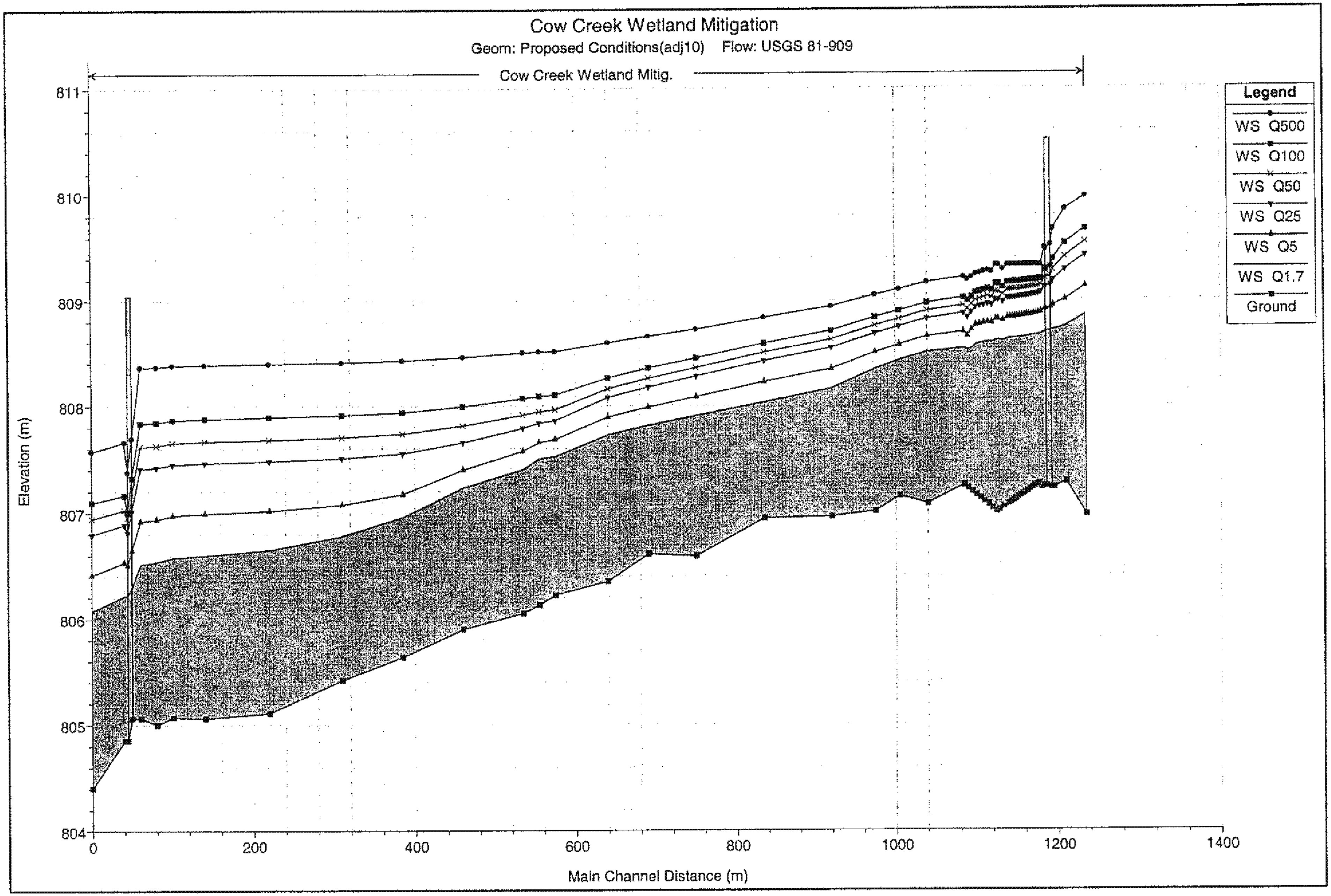
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Wetland Mitig.	10595	Q100	32.73	806.22	808.10		808.15	0.002750	1.38	36.24	49.50	0.39
Wetland Mitig.	10595	Q500	44.91	806.22	808.51		808.55	0.001335	1.15	57.57	55.34	0.28
Wetland Mitig.	10575	Q1.7	8.50	806.13	807.51		807.53	0.001231	0.75	17.39	49.07	0.26
Wetland Mitig.	10575	Q5	14.70	806.13	807.66		807.69	0.001485	0.92	25.90	59.87	0.29
Wetland Mitig.	10575	Q25	23.79	806.13	807.84		807.87	0.001500	1.03	36.89	62.40	0.30
Wetland Mitig.	10575	Q50	28.09	806.13	807.95		807.98	0.001292	1.02	43.77	63.93	0.29
Wetland Mitig.	10575	Q100	32.73	806.13	808.09		808.12	0.001015	0.97	53.02	66.27	0.26
Wetland Mitig.	10575	Q500	44.91	806.13	808.51		808.53	0.000549	0.84	82.20	74.32	0.20
Wetland Mitig.	10555	Q1.7	8.50	806.05	807.41		807.48	0.006303	1.36	9.21	37.92	0.55
Wetland Mitig.	10555	Q5	14.70	806.05	807.58		807.65	0.004927	1.41	17.09	52.66	0.50
Wetland Mitig.	10555	Q25	23.79	806.05	807.79		807.84	0.003172	1.33	29.55	61.25	0.42
Wetland Mitig.	10555	Q50	28.09	806.05	807.92		807.96	0.002278	1.22	37.31	63.39	0.36
Wetland Mitig.	10555	Q100	32.73	806.05	808.07		808.10	0.001555	1.09	47.30	66.05	0.31
Wetland Mitig.	10555	Q500	44.91	806.05	808.50		808.52	0.000700	0.89	77.12	73.43	0.22
Wetland Mitig.	10480	Q1.7	8.50	805.90	807.24		807.25	0.001638	0.70	16.48	38.90	0.28
Wetland Mitig.	10480	Q5	14.70	805.90	807.40		807.43	0.001875	0.88	23.33	44.27	0.31
Wetland Mitig.	10480	Q25	23.79	805.90	807.66		807.69	0.001432	0.93	35.33	47.90	0.29
Wetland Mitig.	10480	Q50	28.09	805.90	807.82		807.84	0.001118	0.90	42.94	49.94	0.26
Wetland Mitig.	10480	Q100	32.73	805.90	808.00		808.02	0.000854	0.86	52.15	52.29	0.23
Wetland Mitig.	10480	Q500	44.91	805.90	808.46		808.48	0.000502	0.80	77.66	58.33	0.19
Wetland Mitig.	10405	Q1.7	8.50	805.63	806.96		807.03	0.005892	1.33	9.48	36.38	0.54
Wetland Mitig.	10405	Q5	14.70	805.63	807.17		807.23	0.003597	1.26	18.41	46.20	0.44
Wetland Mitig.	10405	Q25	23.79	805.63	807.56		807.58	0.001288	0.97	37.50	52.90	0.28
Wetland Mitig.	10405	Q50	28.09	805.63	807.74		807.76	0.000902	0.89	47.53	55.55	0.24
Wetland Mitig.	10405	Q100	32.73	805.63	807.94		807.96	0.000653	0.83	58.98	58.42	0.21
Wetland Mitig.	10405	Q500	44.91	805.63	808.43		808.44	0.000414	0.79	90.54	75.58	0.17
Wetland Mitig.	10330	Q1.7	8.50	805.42	806.78		806.80	0.001663	0.68	14.90	39.31	0.29
Wetland Mitig.	10330	Q5	14.70	805.42	807.08		807.10	0.000904	0.67	28.13	47.97	0.23
Wetland Mitig.	10330	Q25	23.79	805.42	807.51		807.53	0.000447	0.61	50.18	53.64	0.17
Wetland Mitig.	10330	Q50	28.09	805.42	807.71		807.72	0.000355	0.60	60.90	56.19	0.16
Wetland Mitig.	10330	Q100	32.73	805.42	807.92		807.93	0.000287	0.59	72.88	58.91	0.14
Wetland Mitig.	10330	Q500	44.91	805.42	808.41		808.42	0.000209	0.59	105.62	76.86	0.13
Wetland Mitig.	10240	Q1.7	8.50	805.11	806.65		806.67	0.001316	0.72	17.88	46.75	0.26
Wetland Mitig.	10240	Q5	14.70	805.11	807.02		807.03	0.000563	0.61	35.99	51.62	0.18
Wetland Mitig.	10240	Q25	23.79	805.11	807.48		807.49	0.000311	0.56	61.30	57.74	0.14
Wetland Mitig.	10240	Q50	28.09	805.11	807.68		807.69	0.000259	0.55	73.17	60.40	0.13
Wetland Mitig.	10240	Q100	32.73	805.11	807.90		807.90	0.000216	0.54	87.87	86.06	0.12
Wetland Mitig.	10240	Q500	44.91	805.11	808.39		808.40	0.000184	0.58	146.47	136.15	0.12
Wetland Mitig.	10160	Q1.7	8.50	805.06	806.60		806.61	0.000429	0.48	26.40	47.41	0.16
Wetland Mitig.	10160	Q5	14.70	805.06	806.99		807.00	0.000254	0.46	46.04	53.11	0.13
Wetland Mitig.	10160	Q25	23.79	805.06	807.47		807.47	0.000177	0.48	72.76	60.01	0.11
Wetland Mitig.	10160	Q50	28.09	805.06	807.67		807.68	0.000156	0.48	85.25	62.97	0.11
Wetland Mitig.	10160	Q100	32.73	805.06	807.88		807.89	0.000198	0.58	103.80	106.92	0.12
Wetland Mitig.	10160	Q500	44.91	805.06	808.38		808.39	0.000106	0.49	164.26	122.83	0.09
Wetland Mitig.	10120	Q1.7	8.50	805.07	806.58		806.59	0.000404	0.57	22.43	33.15	0.16
Wetland Mitig.	10120	Q5	14.70	805.07	806.98		806.99	0.000335	0.63	37.45	43.05	0.16
Wetland Mitig.	10120	Q25	23.79	805.07	807.45		807.46	0.000257	0.65	60.76	54.91	0.14
Wetland Mitig.	10120	Q50	28.09	805.07	807.66		807.67	0.000226	0.65	74.44	78.12	0.14
Wetland Mitig.	10120	Q100	32.73	805.07	807.87		807.88	0.000225	0.68	92.23	91.04	0.14
Wetland Mitig.	10120	Q500	44.91	805.07	808.38		808.38	0.000131	0.59	146.05	108.35	0.11
Wetland Mitig.	10100	Q1.7	8.50	805.00	806.54		806.58	0.001246	0.86	11.55	20.19	0.27
Wetland Mitig.	10100	Q5	14.70	805.00	806.94		806.97	0.000931	0.92	21.62	30.28	0.24
Wetland Mitig.	10100	Q25	23.79	805.00	807.42		807.45	0.000619	0.91	39.21	42.33	0.21
Wetland Mitig.	10100	Q50	28.09	805.00	807.63		807.66	0.000557	0.92	48.89	60.25	0.20
Wetland Mitig.	10100	Q100	32.73	805.00	807.84		807.87	0.000474	0.91	64.59	78.41	0.19
Wetland Mitig.	10100	Q500	44.91	805.00	808.36		808.38	0.000238	0.73	110.40	92.66	0.14
Wetland Mitig.	10080	Q1.7	8.50	805.06	806.52	806.13	806.54	0.002376	0.85	12.76	20.37	0.24
Wetland Mitig.	10080	Q5	14.70	805.06	806.92	806.27	806.95	0.001476	0.80	21.94	24.60	0.19

HEC-RAS Plan: Prop10,81 River: Cow Creek Reach: Wetland Mitig. (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Wetland Mitig.	10080	Q25	23.79	805.06	807.41	806.42	807.44	0.001068	0.80	35.58	35.76	0.17
Wetland Mitig.	10080	Q50	28.09	805.06	807.62	806.49	807.64	0.000929	0.80	44.45	49.55	0.16
Wetland Mitig.	10080	Q100	32.73	805.06	807.84	806.55	807.86	0.000758	0.76	56.93	64.99	0.15
Wetland Mitig.	10080	Q500	44.91	805.06	808.36	806.71	808.37	0.000389	0.61	92.82	70.18	0.11
Wetland Mitig.	10067		Bridge									
Wetland Mitig.	10060	Q1.7	8.50	804.85	806.22		806.35	0.008163	1.68	5.55	7.03	0.55
Wetland Mitig.	10060	Q5	14.70	804.85	806.54		806.74	0.008897	2.09	7.95	7.90	0.59
Wetland Mitig.	10060	Q25	23.79	804.85	806.89		807.18	0.009602	2.54	10.90	8.79	0.63
Wetland Mitig.	10060	Q50	28.09	804.85	807.03		807.35	0.009884	2.71	12.15	9.07	0.65
Wetland Mitig.	10060	Q100	32.73	804.85	807.17		807.53	0.010177	2.89	13.41	9.35	0.67
Wetland Mitig.	10060	Q500	44.91	804.85	807.67		808.00	0.007482	2.88	19.71	16.13	0.59
Wetland Mitig.	10020	Q1.7	8.50	804.41	806.08	805.65	806.15	0.003000	1.20	7.34	8.89	0.39
Wetland Mitig.	10020	Q5	14.70	804.41	806.41	805.88	806.52	0.003001	1.46	10.53	9.94	0.41
Wetland Mitig.	10020	Q25	23.79	804.41	806.80	806.16	806.94	0.003000	1.73	14.54	11.11	0.42
Wetland Mitig.	10020	Q50	28.09	804.41	806.95	806.28	807.10	0.003001	1.83	16.26	11.56	0.43
Wetland Mitig.	10020	Q100	32.73	804.41	807.10	806.39	807.27	0.003000	1.93	18.03	11.99	0.43
Wetland Mitig.	10020	Q500	44.91	804.41	807.57	806.66	807.79	0.003004	2.22	25.75	34.74	0.45

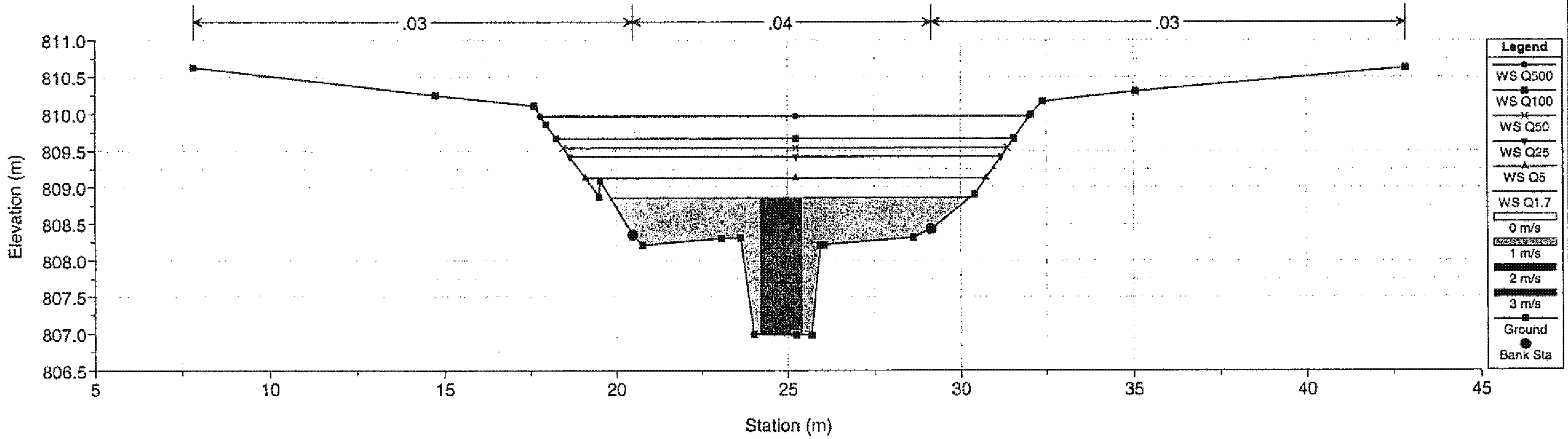


Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
Cow Creek Wetland Mitig.
Elevation (m)
811
810
809
808
807
806
805
804
0
200
400
600
800
1000
1200
1400
Main Channel Distance (m)
Legend
WS Q500
WS Q100
WS Q50
WS Q25
WS Q5
WS Q1.7
Ground

Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10)   Flow: USGS 81-909

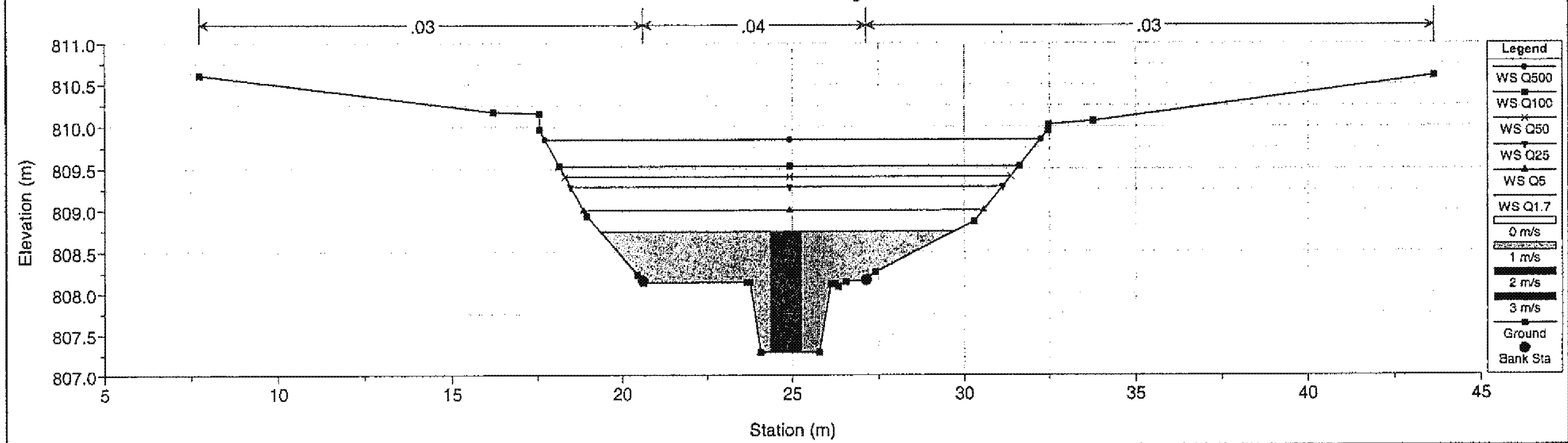
River = Cow Creek   Reach = Wetland Mitig.   RS = 11255   XS26

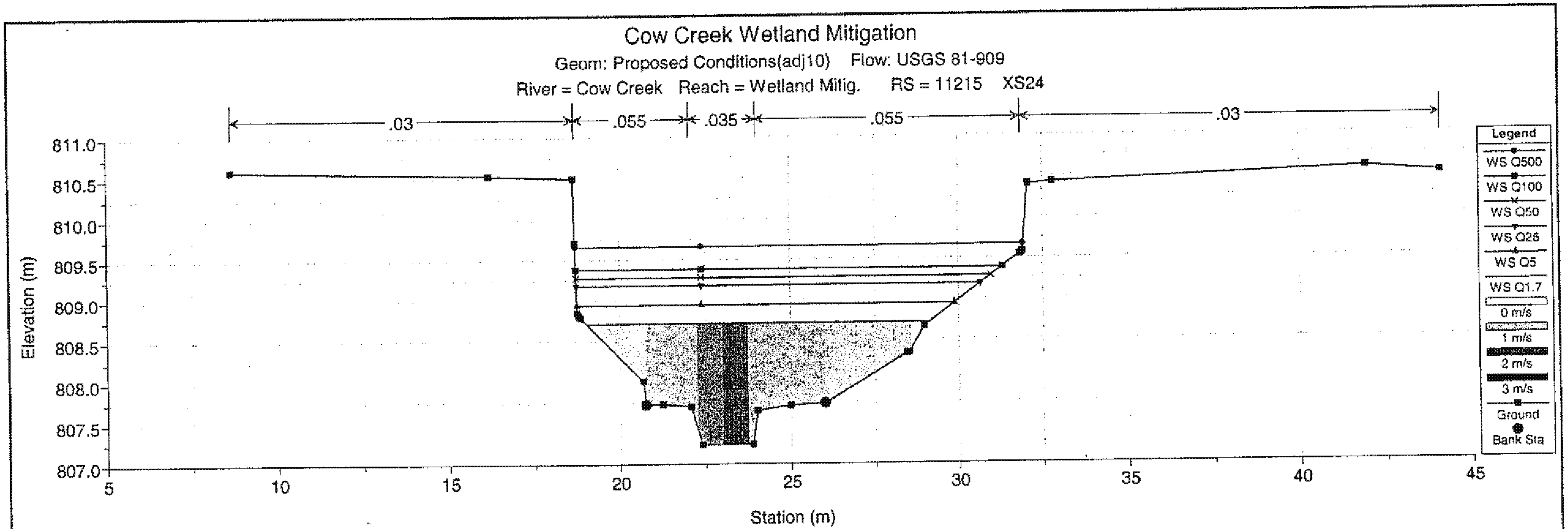


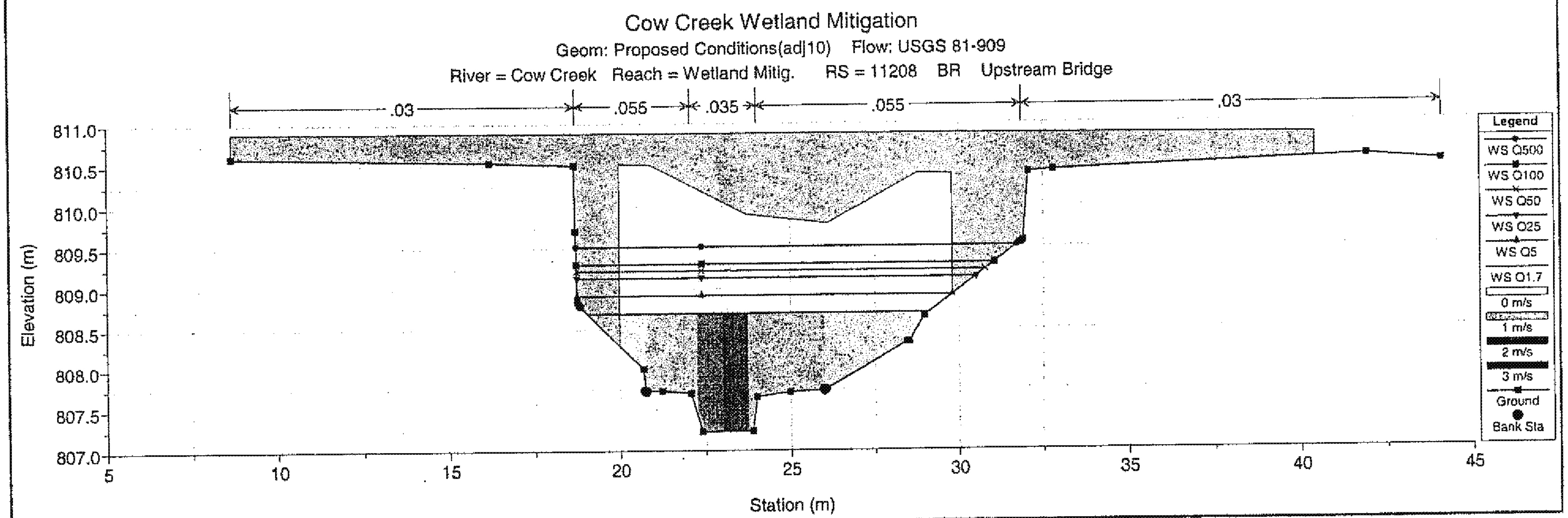
Cow Creek Wetland Mitigation

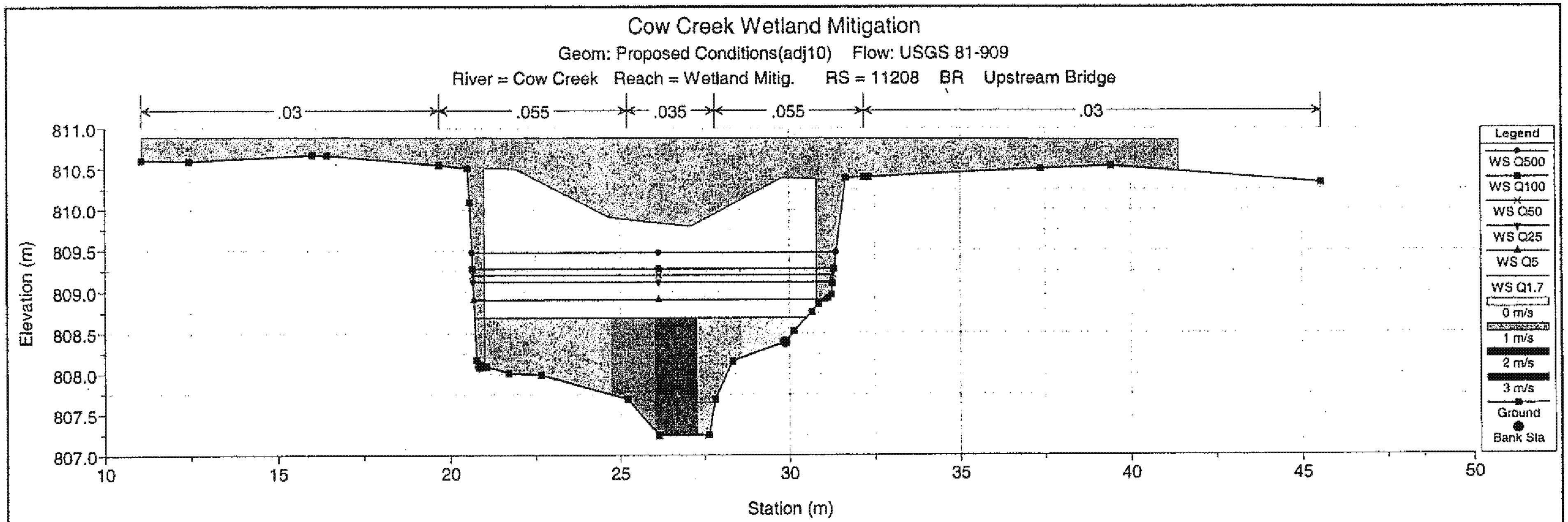
Geom: Proposed Conditions(adj10)   Flow: USGS 81-909

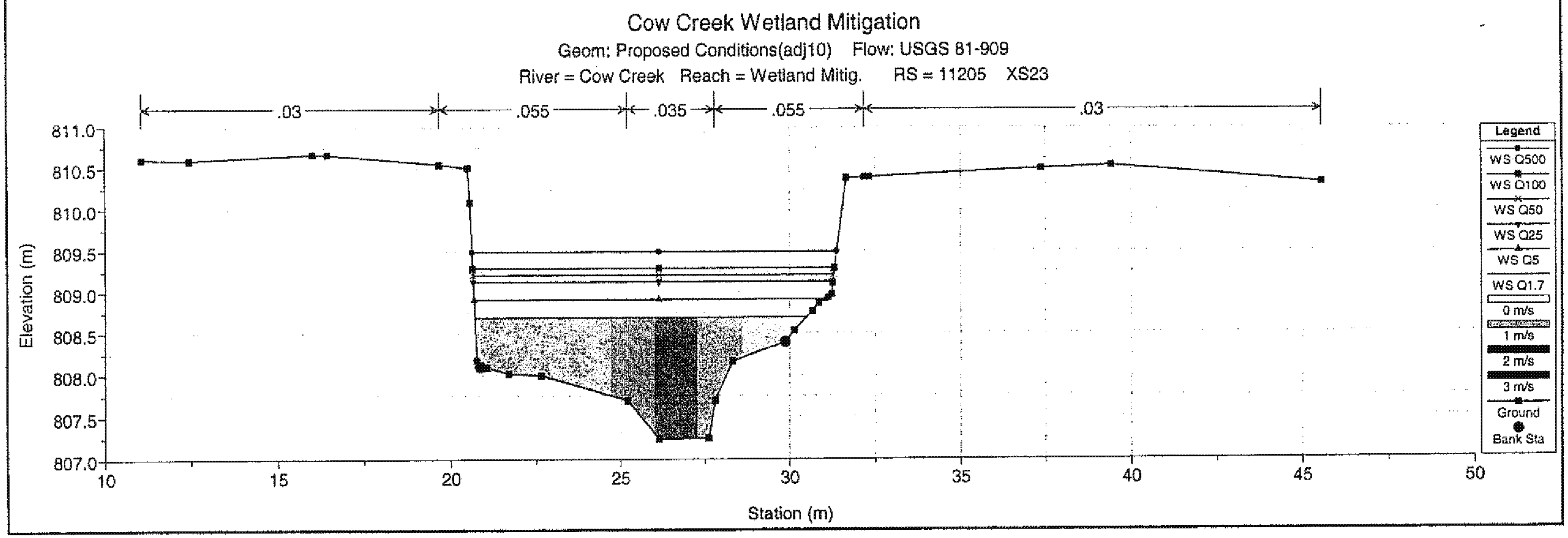
River = Cow Creek   Reach = Wetland Mitig.   RS = 11230   XS25

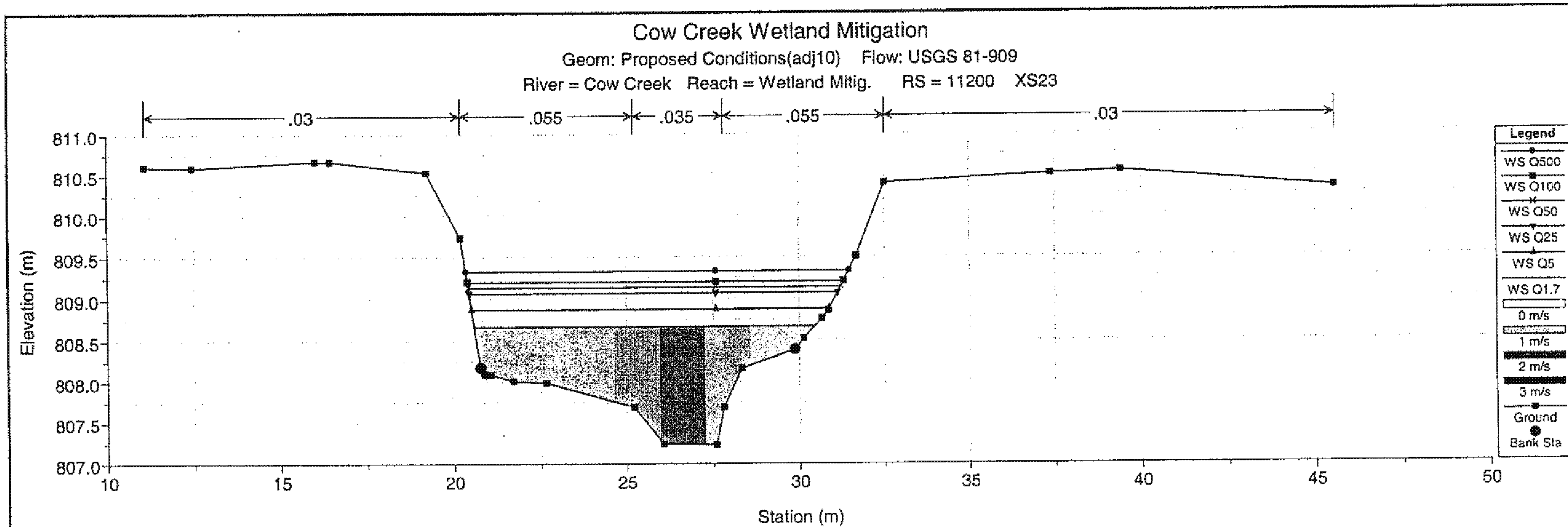


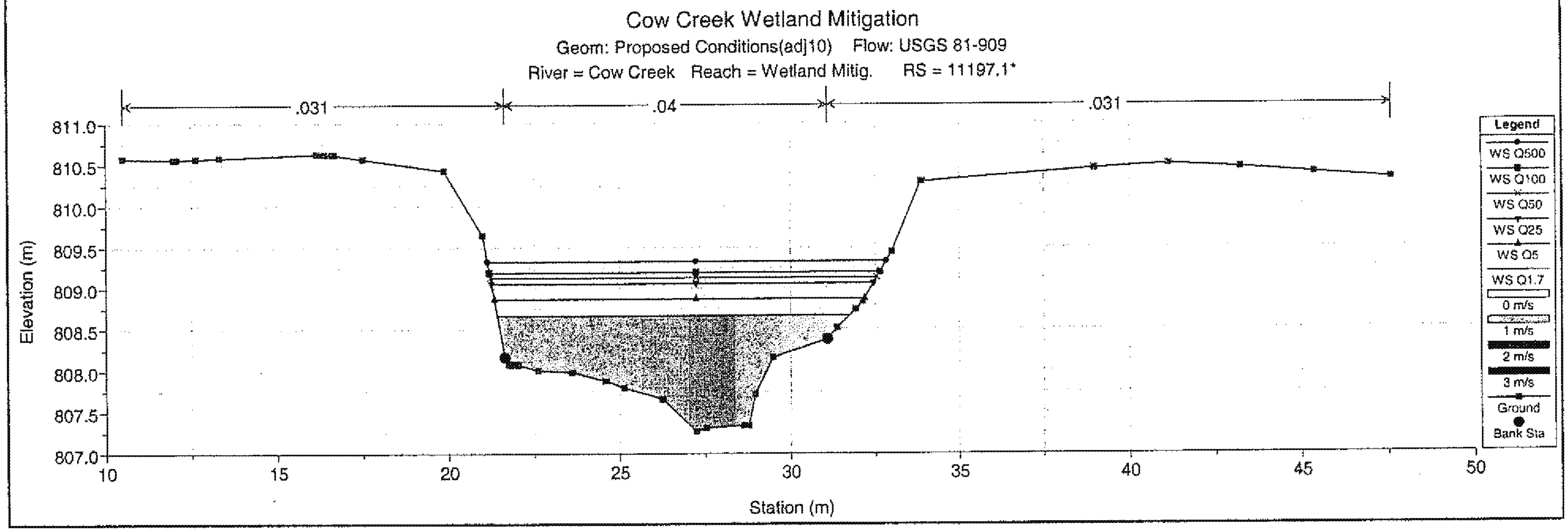

Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11215 XS24
.03
.055
.035
.055
.03
Elevation (m)
811.0
810.5
810.0
809.5
809.0
808.5
808.0
807.5
807.0
5
10
15
20
25
30
35
40
45
Station (m)
Legend
WS Q500
WS Q100
WS Q50
WS Q25
WS Q5
WS Q1.7
0 m/s
1 m/s
2 m/s
3 m/s
Ground
Bank Sta


Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11208 BR Upstream Bridge
.03
.055
.035
.055
.03
Elevation (m)
811.0
810.5
810.0
809.5
809.0
808.5
808.0
807.5
807.0
5
10
15
20
25
30
35
40
45
Station (m)
Legend
WS Q500
WS Q100
WS Q50
WS Q25
WS Q5
WS Q1.7
0 m/s
1 m/s
2 m/s
3 m/s
Ground
Bank Sta

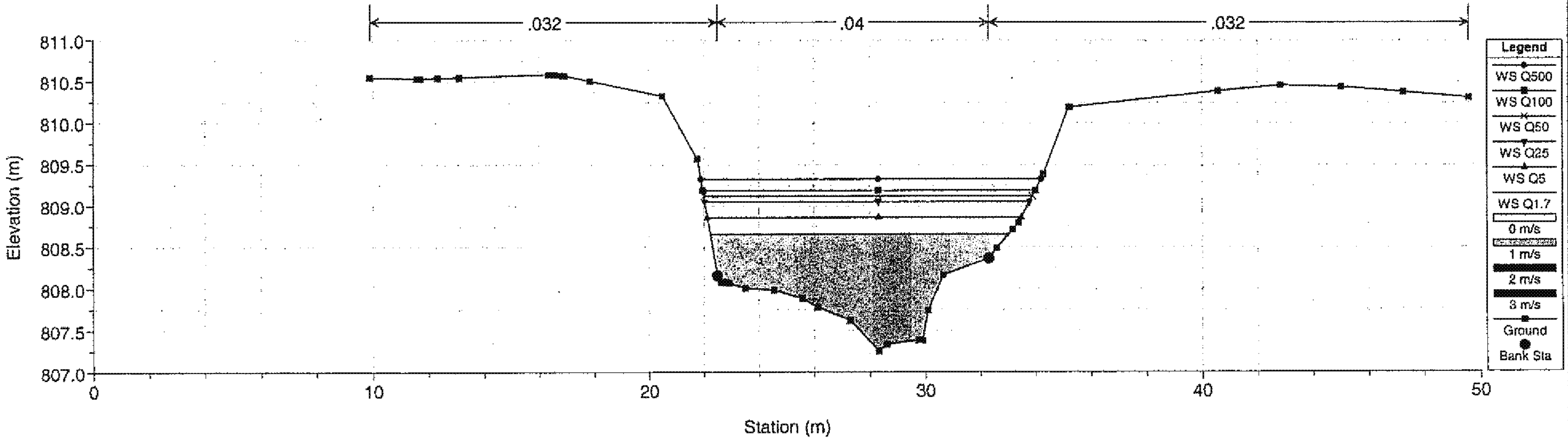

Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11208 BR Upstream Bridge
.03
.055
.035
.055
.03
Elevation (m)
811.0
810.5
810.0
809.5
809.0
808.5
808.0
807.5
807.0
10
15
20
25
30
35
40
45
50
Station (m)
Legend
WS Q500
WS Q100
WS Q50
WS Q25
WS Q5
WS Q1.7
0 m/s
1 m/s
2 m/s
3 m/s
Ground
Bank Sta


Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11205 XS23
.03
.055
.035
.055
.03
Elevation (m)
811.0
810.5
810.0
809.5
809.0
808.5
808.0
807.5
807.0
10
15
20
25
30
35
40
45
50
Station (m)
Legend
WS Q500
WS Q100
WS Q50
WS Q25
WS Q5
WS Q1.7
0 m/s
1 m/s
2 m/s
3 m/s
Ground
Bank Sta

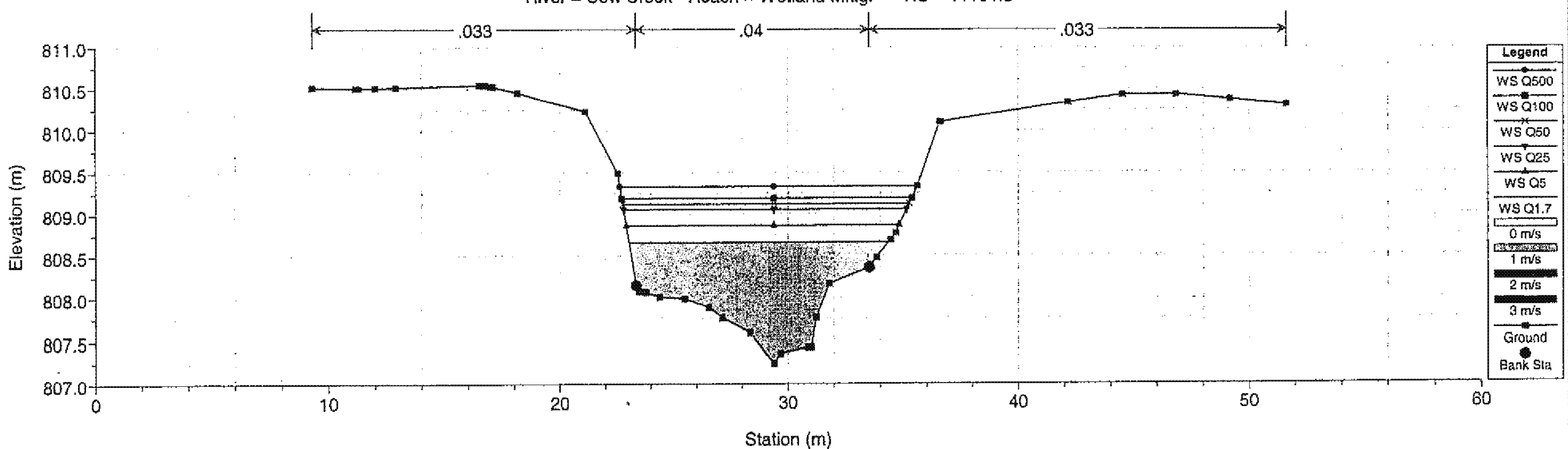

Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11200 XS23
.03
.055
.035
.055
.03
Elevation (m)
811.0
810.5
810.0
809.5
809.0
808.5
808.0
807.5
807.0
10
15
20
25
30
35
40
45
50
Station (m)
Legend
WS Q500
WS Q100
WS Q50
WS Q25
WS Q5
WS Q1.7
0 m/s
1 m/s
2 m/s
3 m/s
Ground
Bank Sta


Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11197.1*
.031
.04
.031
Elevation (m)
811.0
810.5
810.0
809.5
809.0
808.5
808.0
807.5
807.0
10
15
20
25
30
35
40
45
50
Station (m)
Legend
WS Q500
WS Q100
WS Q50
WS Q25
WS Q5
WS Q1.7
0 m/s
1 m/s
2 m/s
3 m/s
Ground
Bank Sta

Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11194.2*



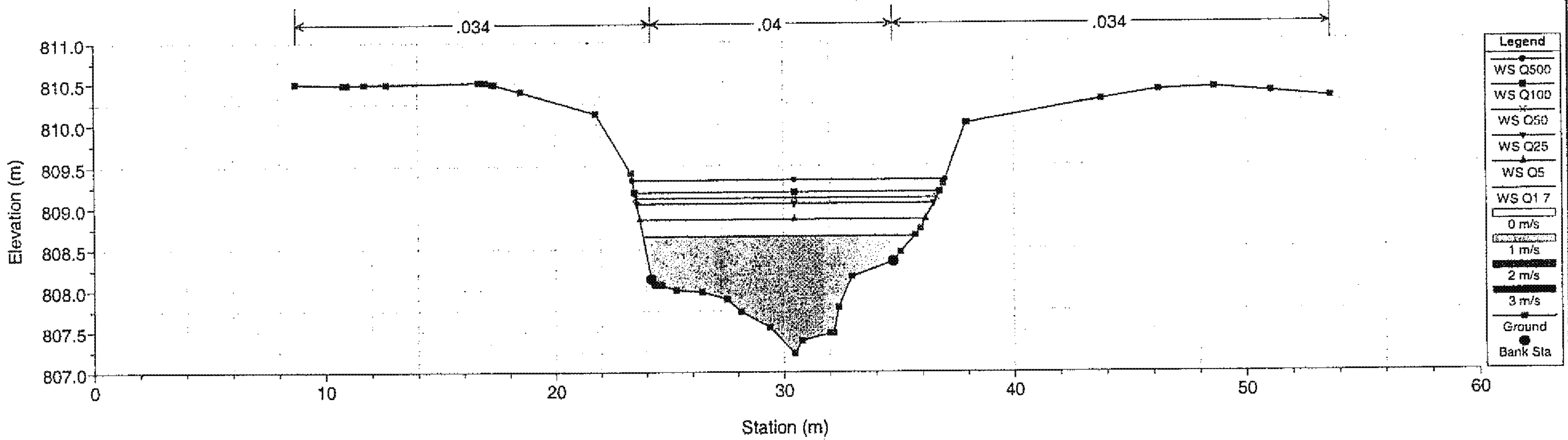
Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11191.3*



Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10) Flow: USGS 81-909

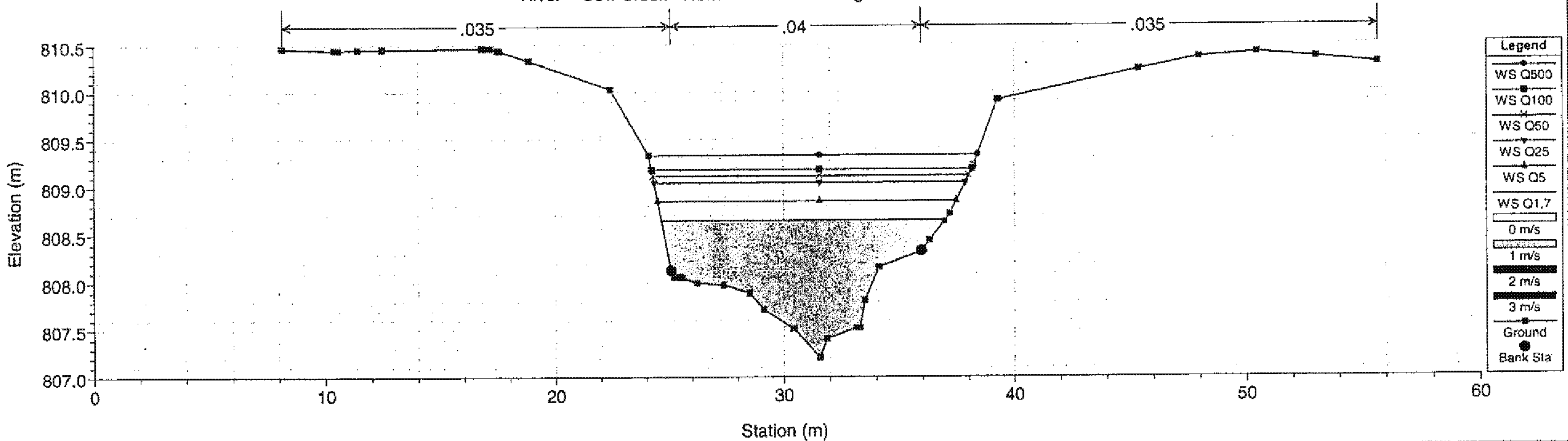
River = Cow Creek Reach = Wetland Mitig. RS = 11188.4*



Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10) Flow: USGS 81-909

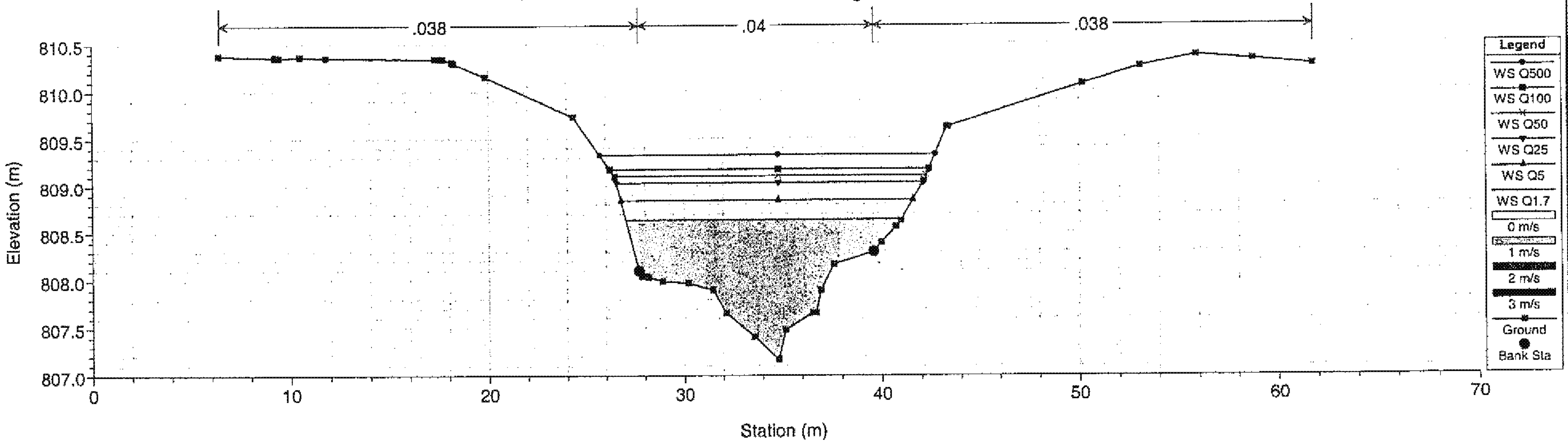
River = Cow Creek Reach = Wetland Mitig. RS = 11185.5*



Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10) Flow: USGS 81-909

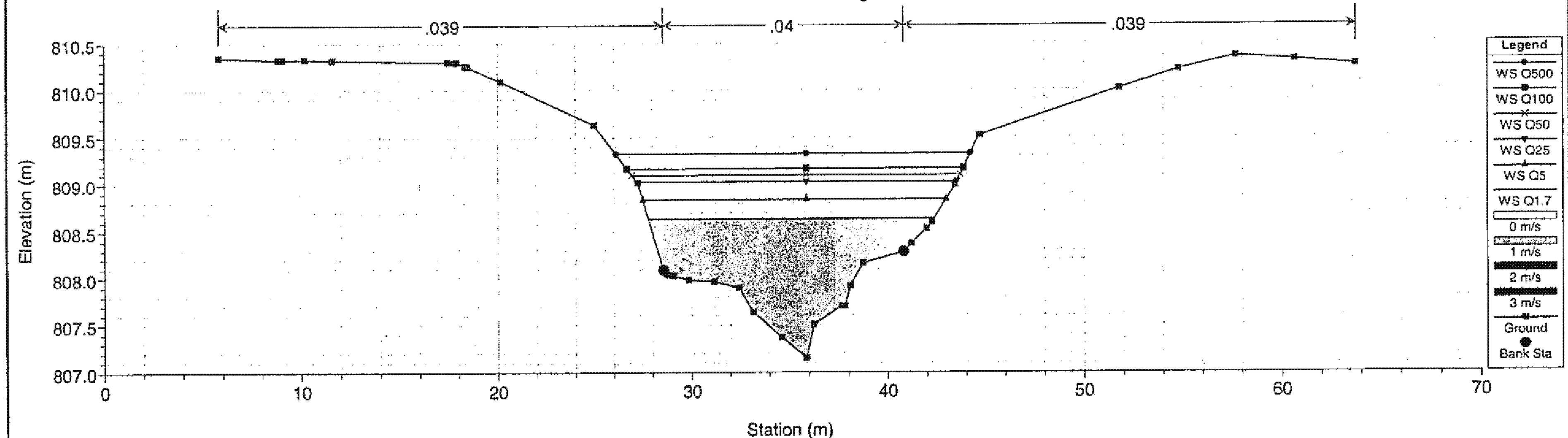
River = Cow Creek Reach = Wetland Mitig. RS = 11176.8*

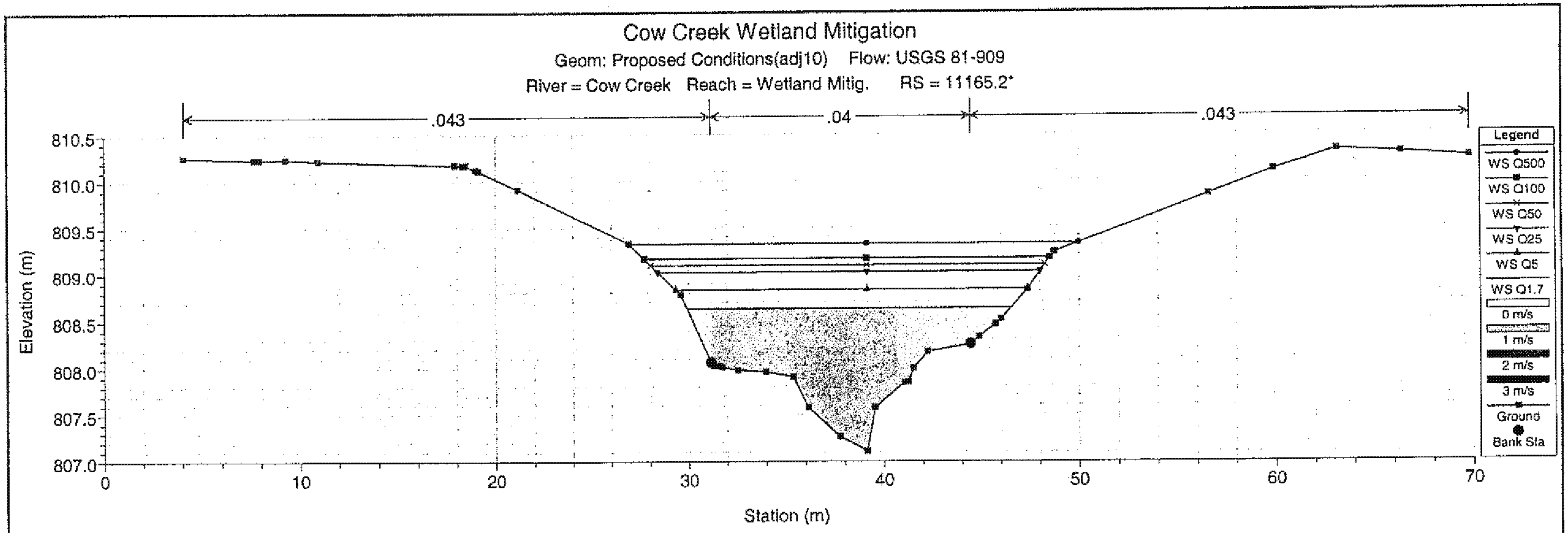


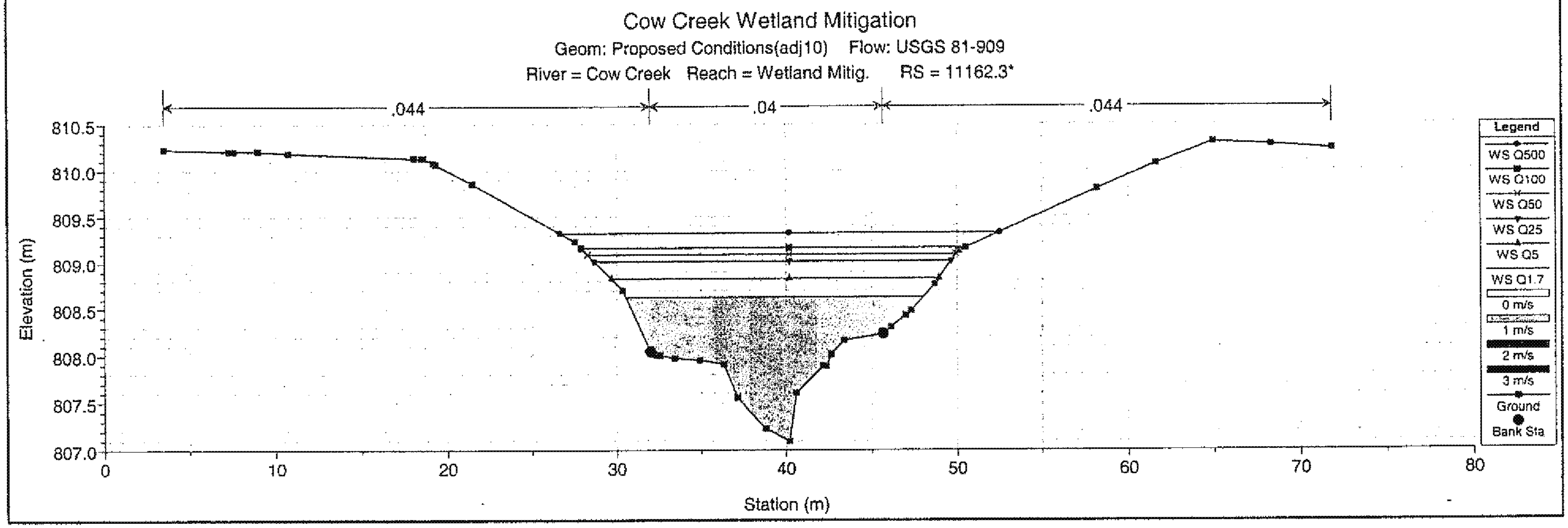
Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10) Flow: USGS 81-909

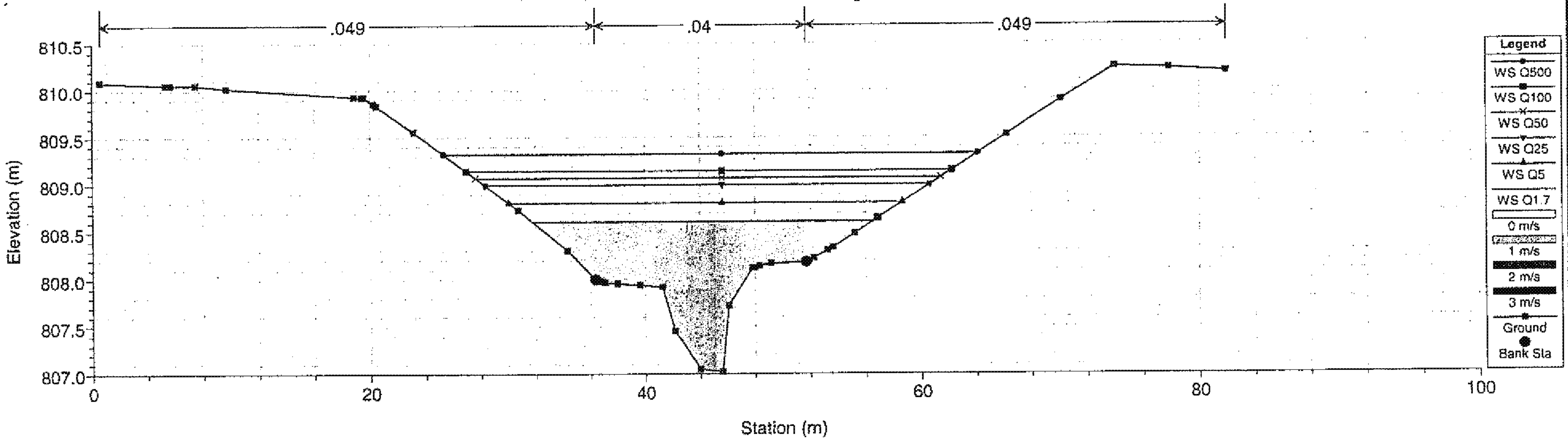
River = Cow Creek Reach = Wetland Mitig. RS = 11173.9*



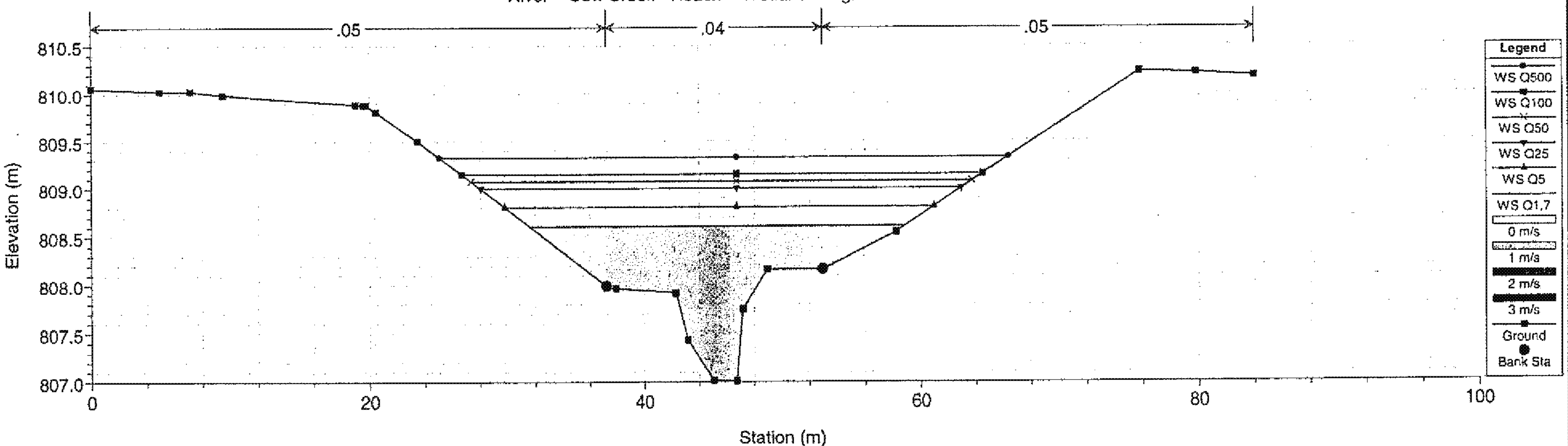

Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11165.2*
.043
.04
.043
Elevation (m)
Station (m)
Legend
WS Q500
WS Q100
WS Q50
WS Q25
WS Q5
WS Q1.7
0 m/s
1 m/s
2 m/s
3 m/s
Ground
Bank Sta

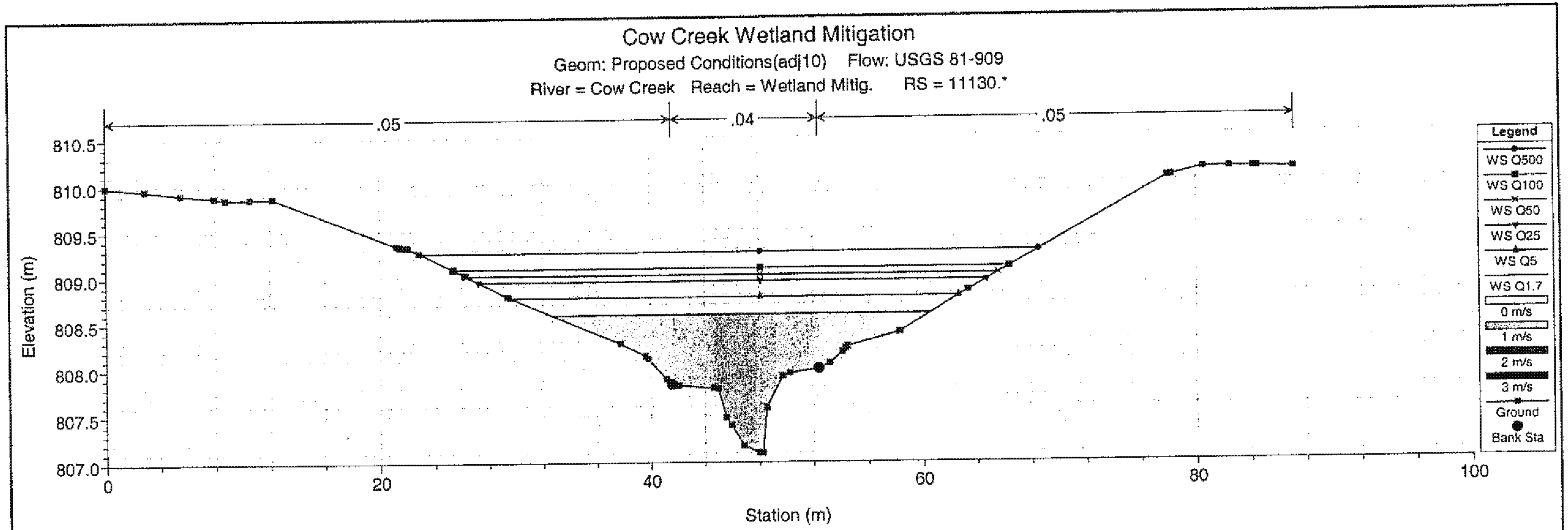

Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11162.3*
.044
.04
.044
Elevation (m)
Station (m)
Legend
WS Q500
WS Q100
WS Q50
WS Q25
WS Q5
WS Q1.7
0 m/s
1 m/s
2 m/s
3 m/s
Ground
Bank Sta

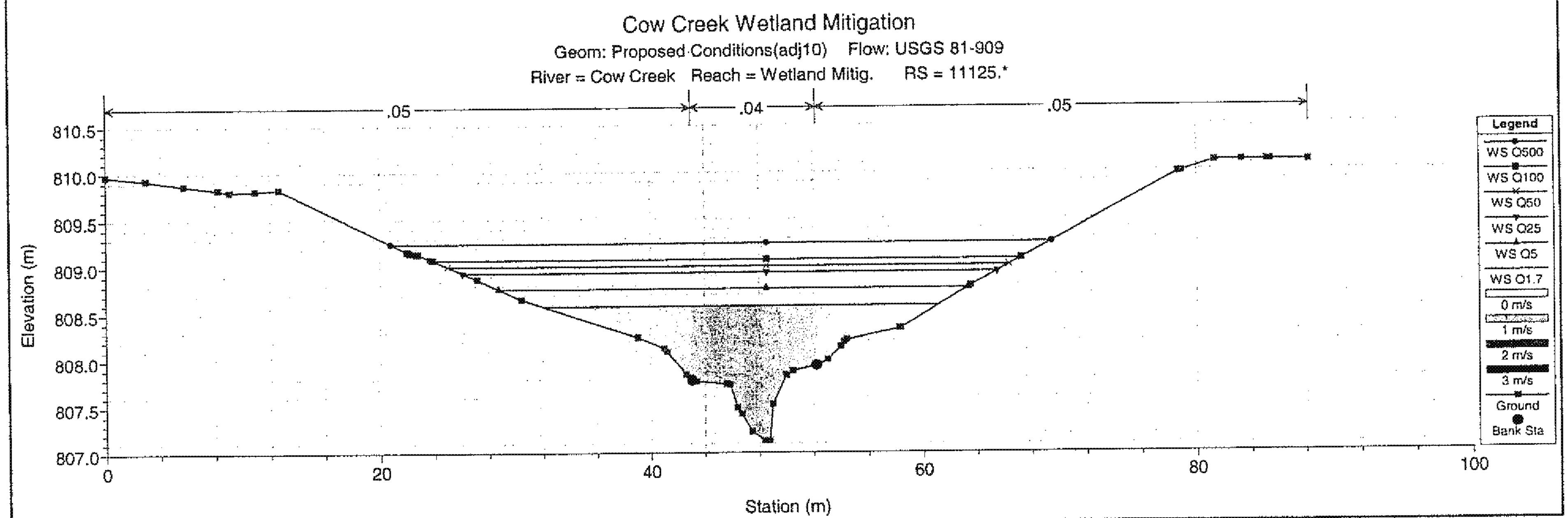
Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11147.8*



Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11145 XS21



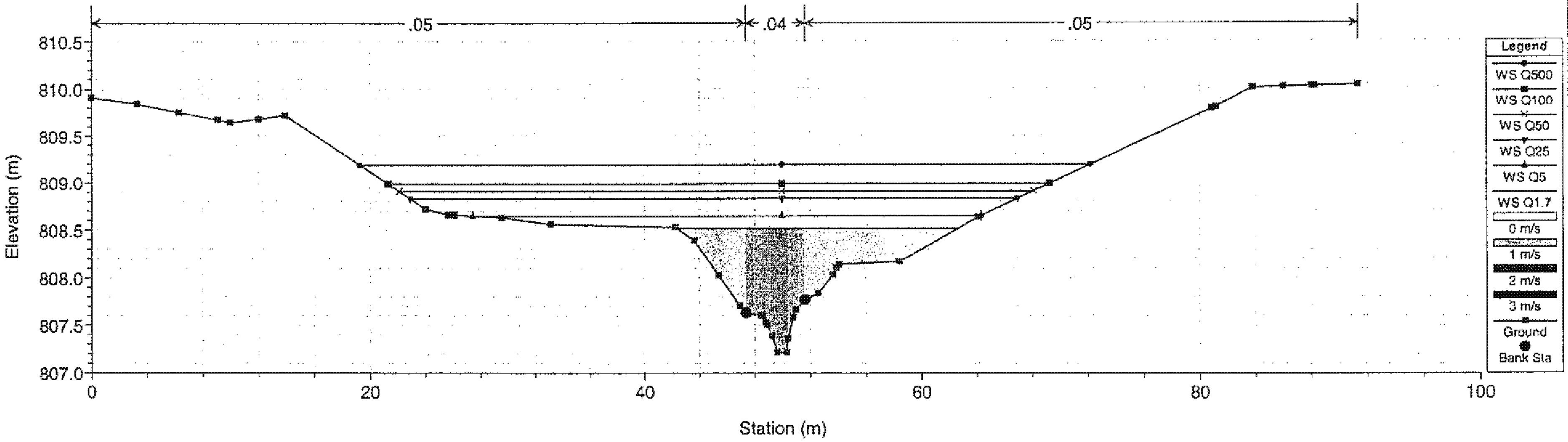

Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11130.*
.05
.04
.05
Elevation (m)
810.5
810.0
809.5
809.0
808.5
808.0
807.5
807.0
0
20
40
60
80
100
Station (m)
Legend
WS Q500
WS Q100
WS Q50
WS Q25
WS Q5
WS Q1.7
0 m/s
1 m/s
2 m/s
3 m/s
Ground
Bank Sta


Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11125.*
.05
.04
.05
Elevation (m)
810.5
810.0
809.5
809.0
808.5
808.0
807.5
807.0
0
20
40
60
80
100
Station (m)
Legend
WS Q500
WS Q100
WS Q50
WS Q25
WS Q5
WS Q1.7
0 m/s
1 m/s
2 m/s
3 m/s
Ground
Bank Sta

Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10) Flow: USGS 81-909

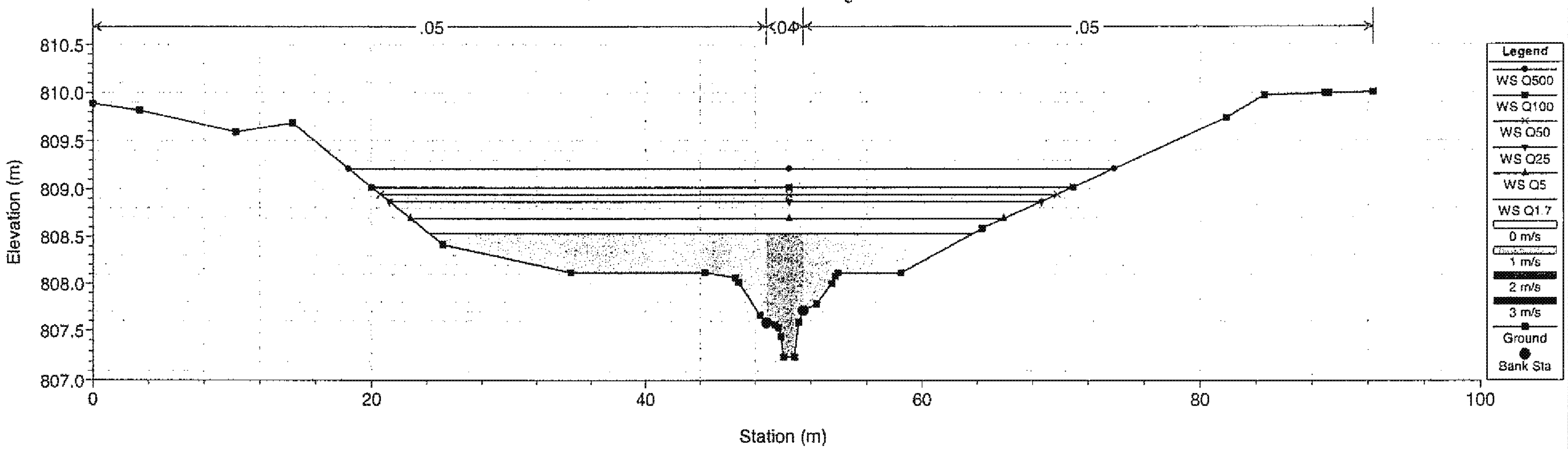
River = Cow Creek Reach = Wetland Mitig. RS = 11110.*

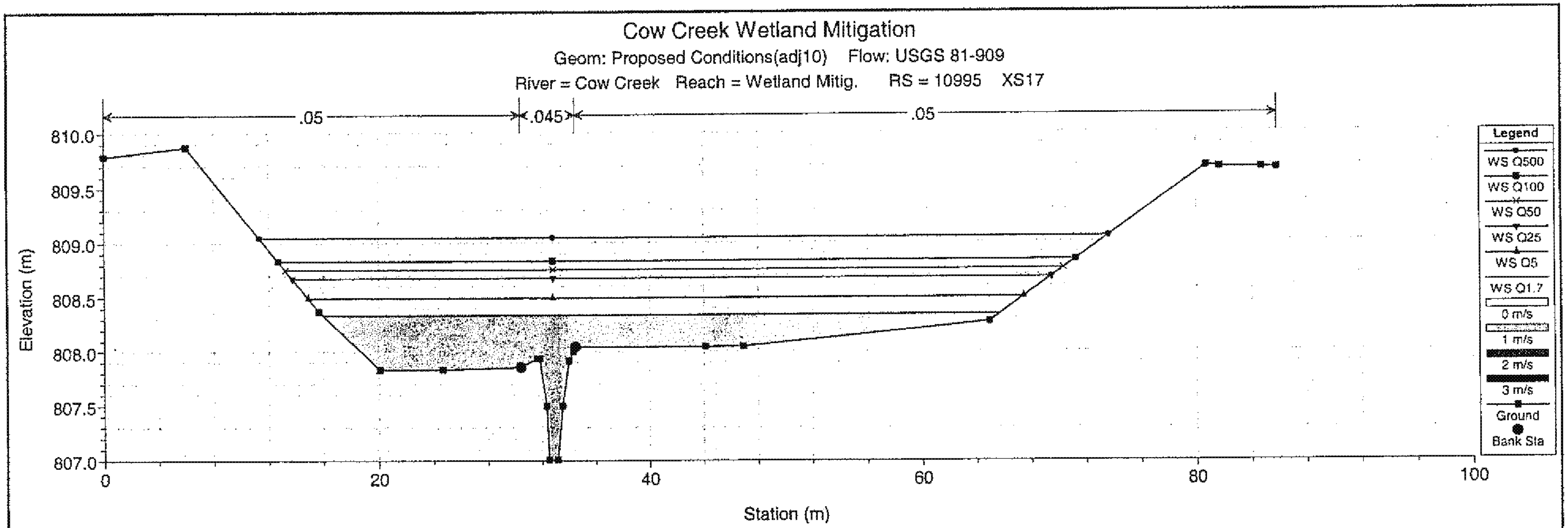


Cow Creek Wetland Mitigation

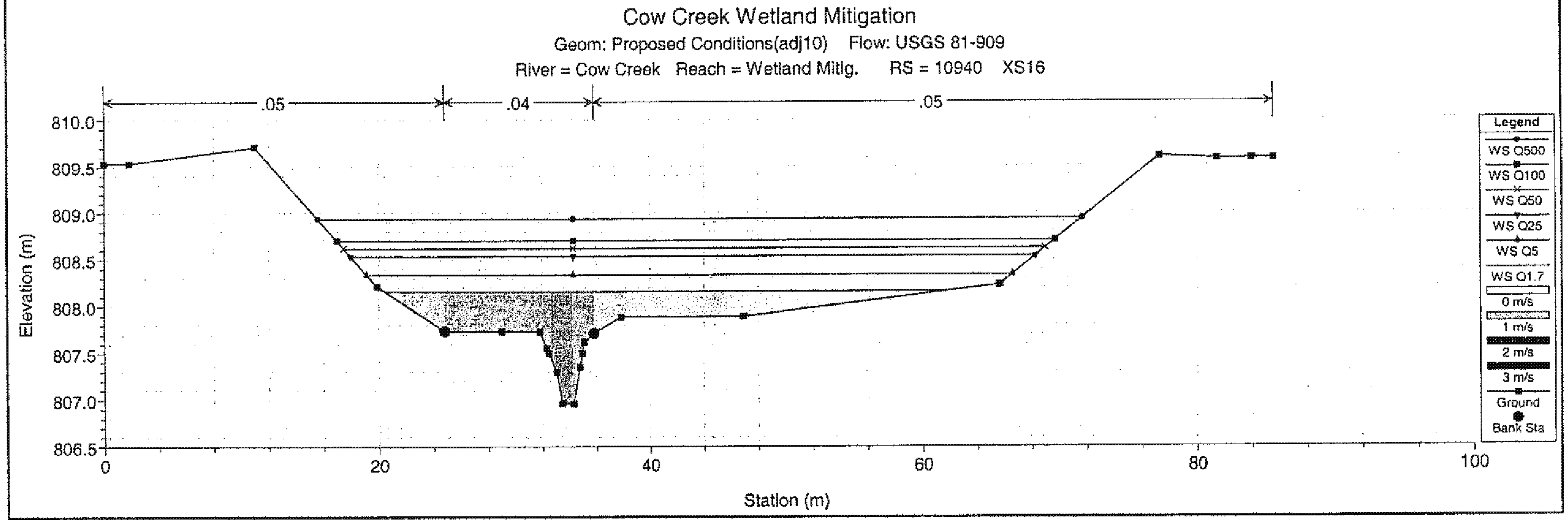
Geom: Proposed Conditions(adj10) Flow: USGS 81-909

River = Cow Creek Reach = Wetland Mitig. RS = 11105 XS20

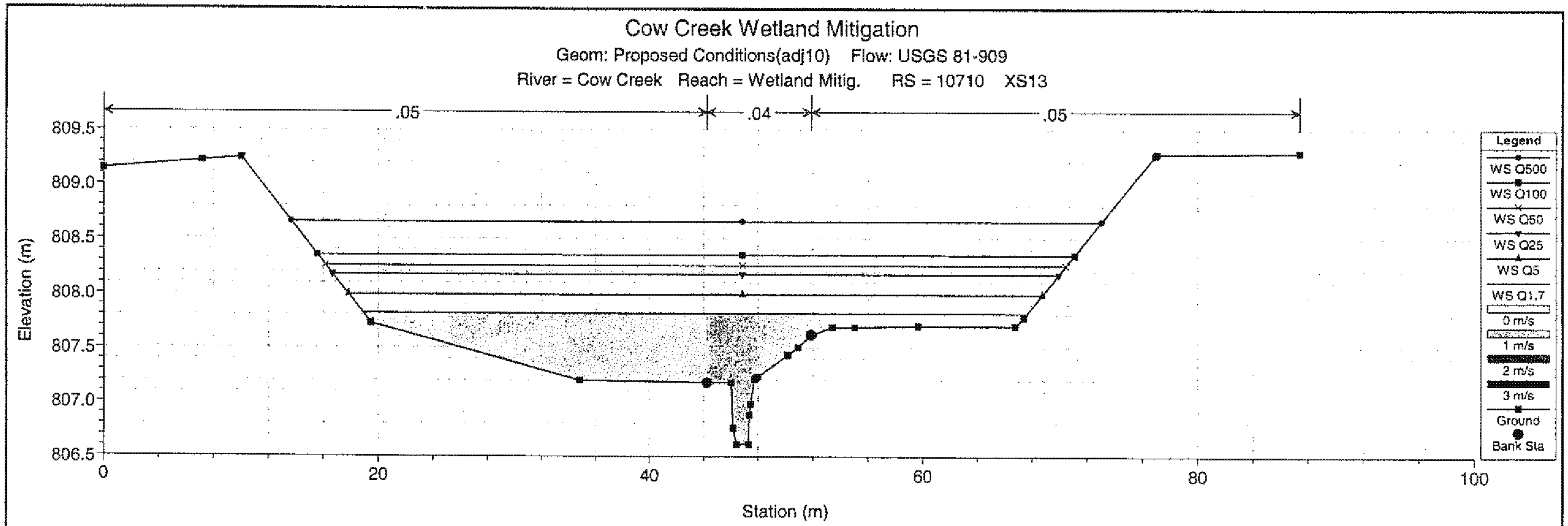


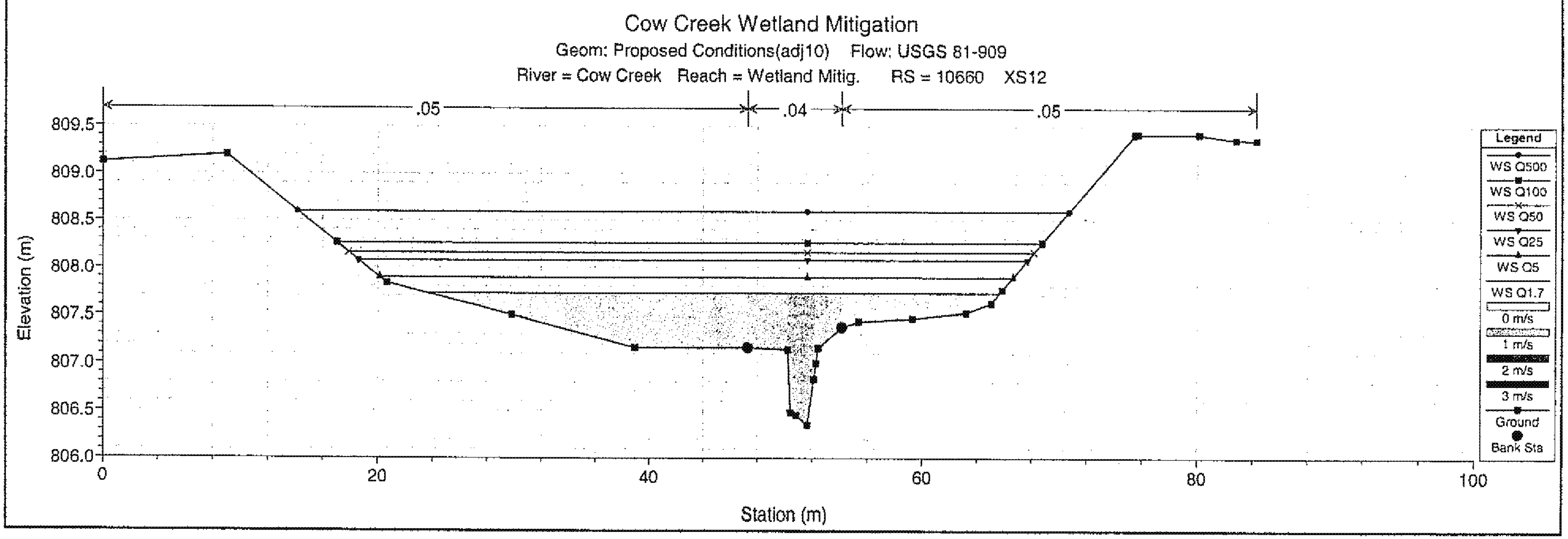


Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10995 XS17
.05
.045
.05
Elevation (m)
810.0
809.5
809.0
808.5
808.0
807.5
807.0
0
20
40
60
80
100
Station (m)
Legend
WS Q500
WS Q100
WS Q50
WS Q25
WS Q5
WS Q1.7
0 m/s
1 m/s
2 m/s
3 m/s
Ground
Bank Sta



Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10940 XS16
.05
.04
.05
Elevation (m)
810.0
809.5
809.0
808.5
808.0
807.5
807.0
806.5
0
20
40
60
80
100
Station (m)
Legend
WS Q500
WS Q100
WS Q50
WS Q25
WS Q5
WS Q1.7
0 m/s
1 m/s
2 m/s
3 m/s
Ground
Bank Sta

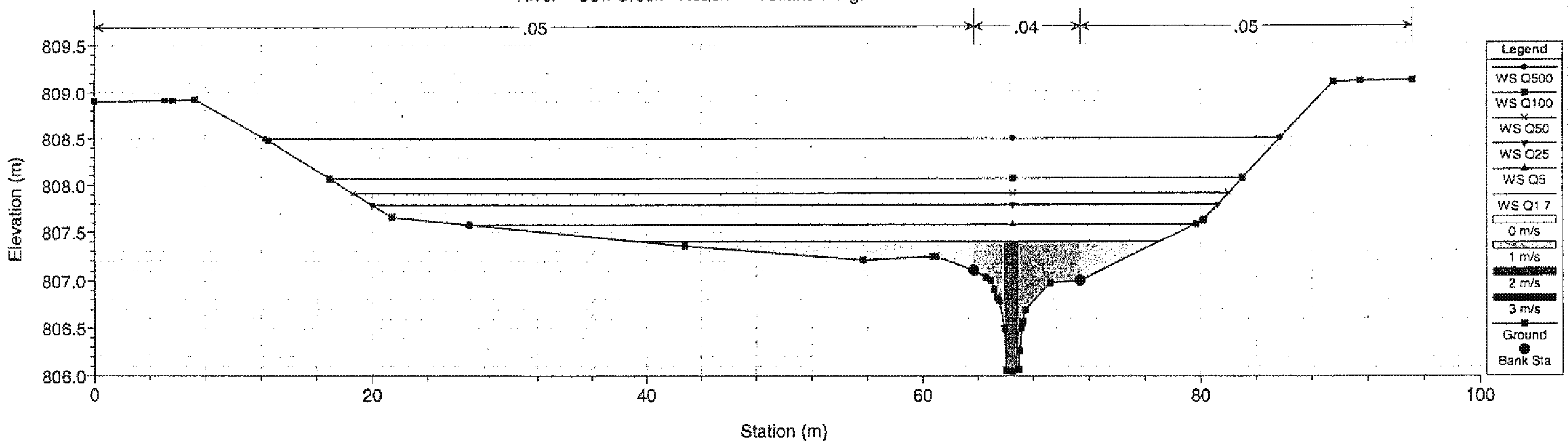

Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10710 XS13
.05
.04
.05
Elevation (m)
809.5
809.0
808.5
808.0
807.5
807.0
806.5
Station (m)
0
20
40
60
80
100
Legend
WS Q500
WS Q100
WS Q50
WS Q25
WS Q5
WS Q1.7
0 m/s
1 m/s
2 m/s
3 m/s
Ground
Bank Sta


Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10660 XS12
.05
.04
.05
Elevation (m)
809.5
809.0
808.5
808.0
807.5
807.0
806.5
806.0
Station (m)
0
20
40
60
80
100
Legend
WS Q500
WS Q100
WS Q50
WS Q25
WS Q5
WS Q1.7
0 m/s
1 m/s
2 m/s
3 m/s
Ground
Bank Sta

Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10) Flow: USGS 81-909

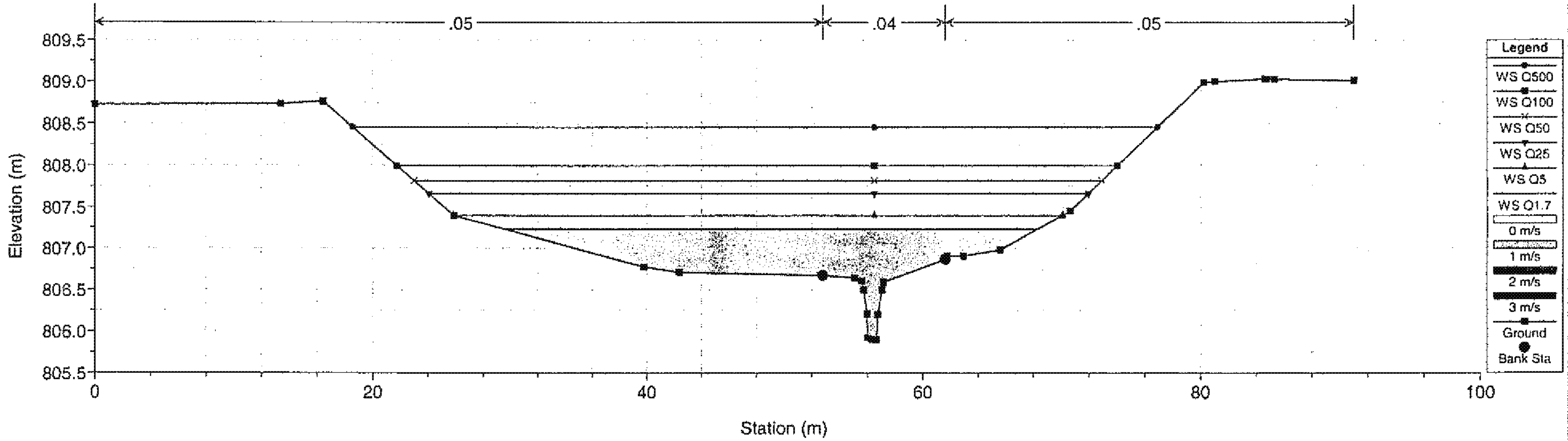
River = Cow Creek Reach = Wetland Mitig. RS = 10555 XS9



Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10) Flow: USGS 81-909

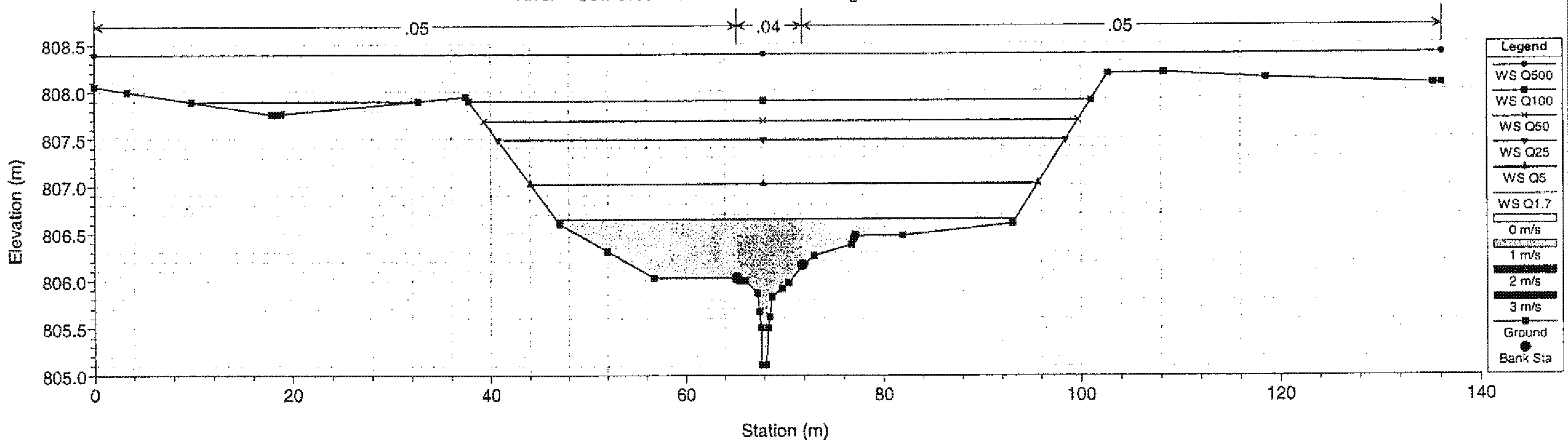
River = Cow Creek Reach = Wetland Mitig. RS = 10480 XS8



Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10) Flow: USGS 81-909

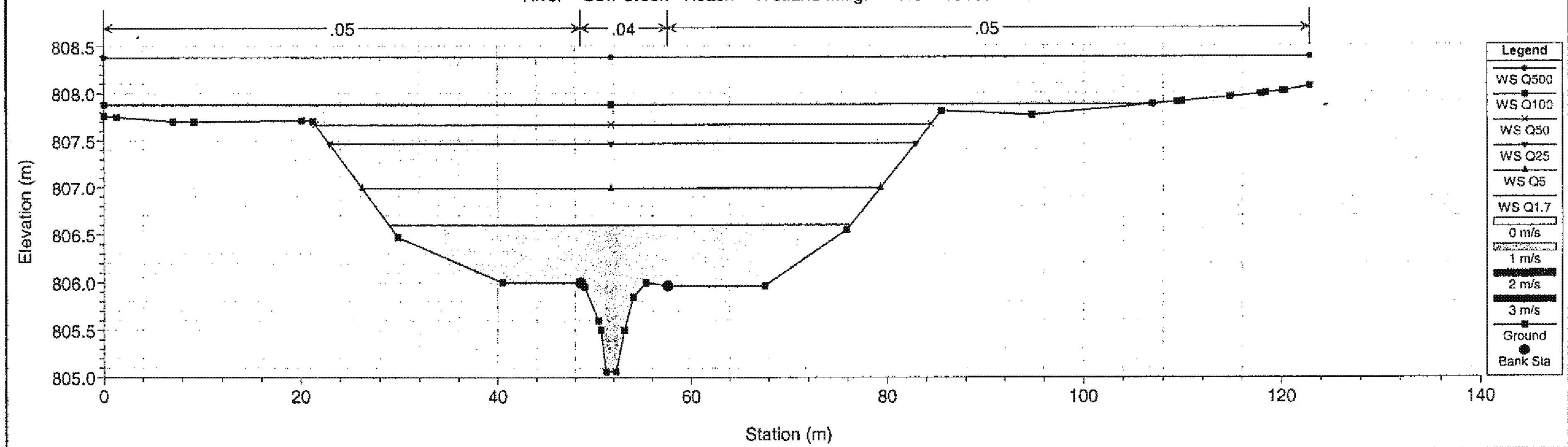
River = Cow Creek Reach = Wetland Mitig. RS = 10240 XS5



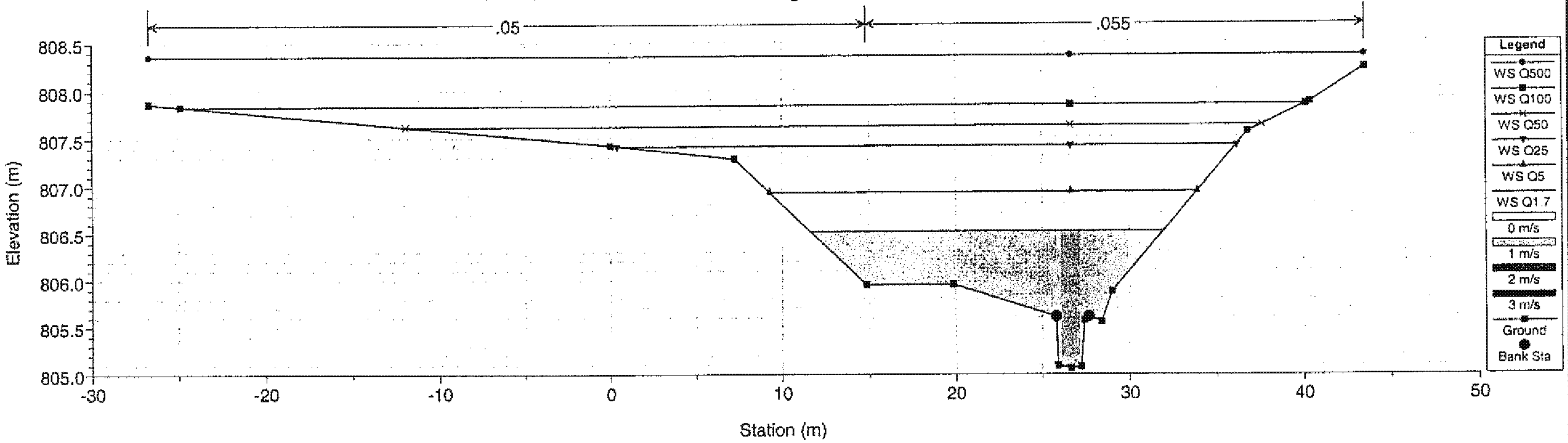
Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10) Flow: USGS 81-909

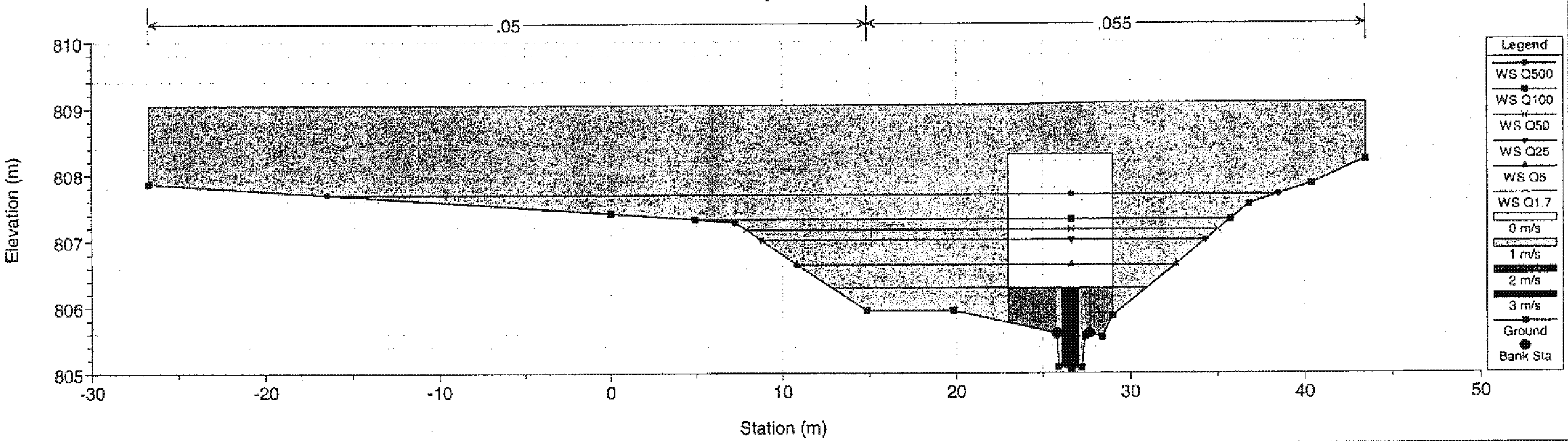
River = Cow Creek Reach = Wetland Mitig. RS = 10160 XS4



Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10080 XS3 Above Bridge



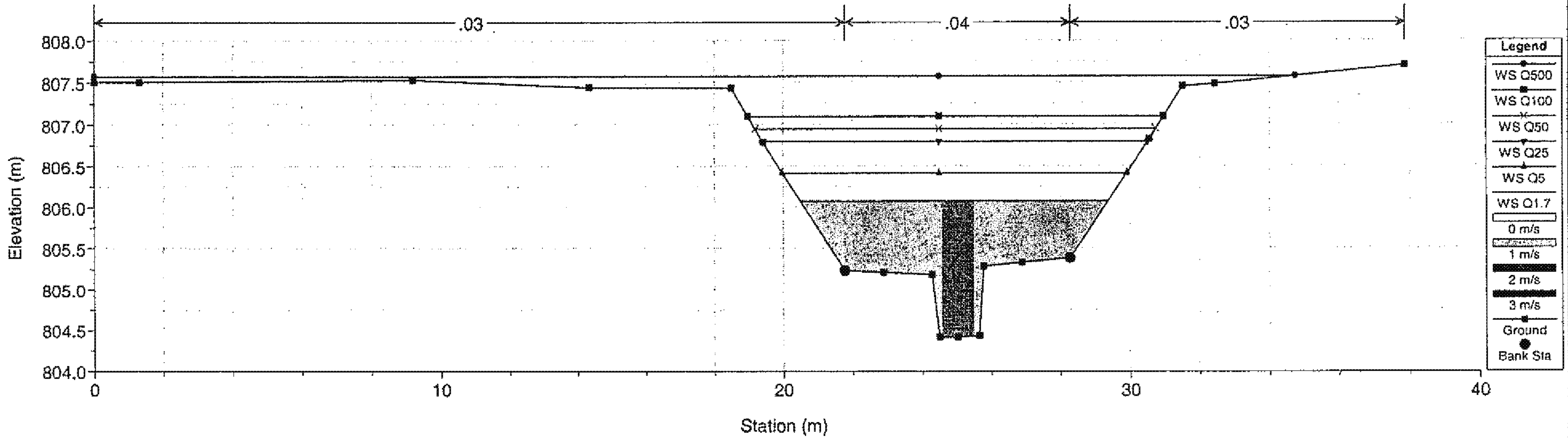
Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10067 BR Downstream Bridge



Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10) Flow: USGS 81-909

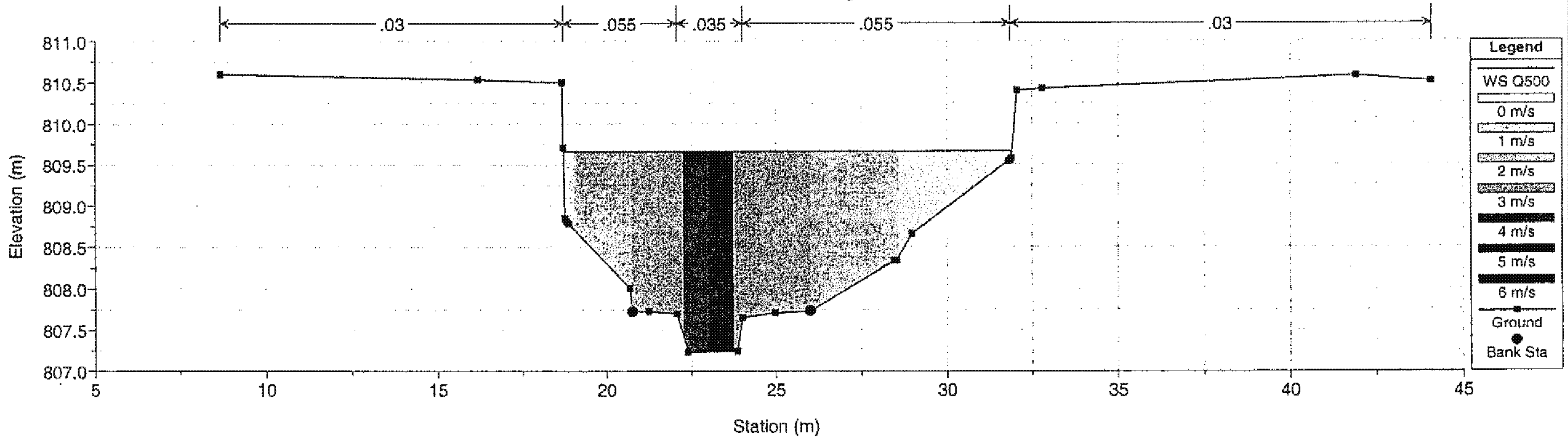
River = Cow Creek Reach = Wetland Mitig. RS = 10020 XS1



Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10)   Flow: USGS 81-909

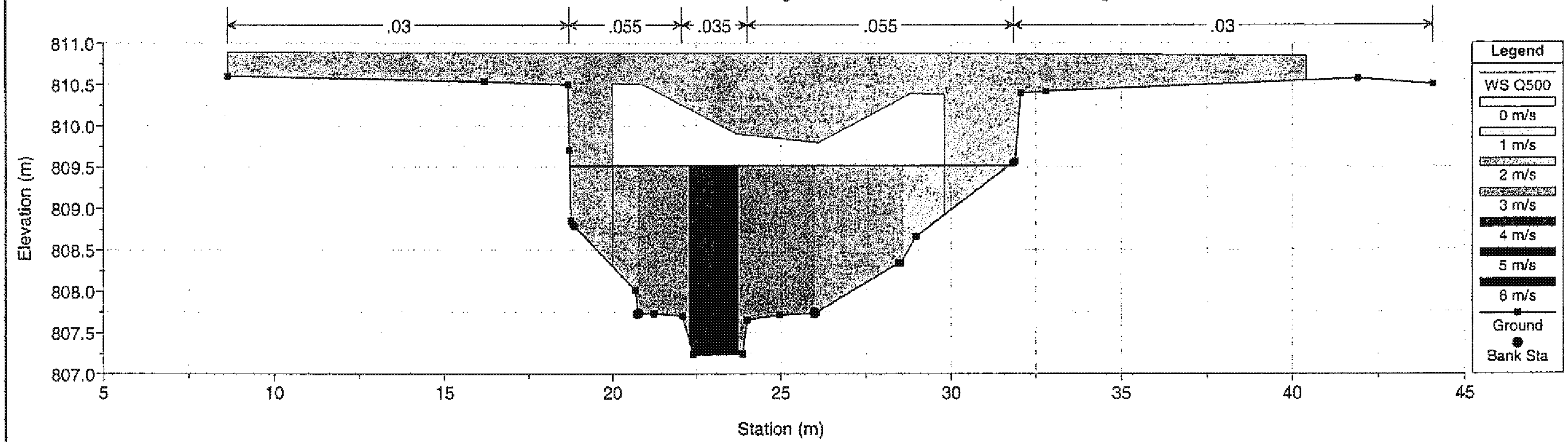
River = Cow Creek   Reach = Wetland Mitig.   RS = 11215   XS24

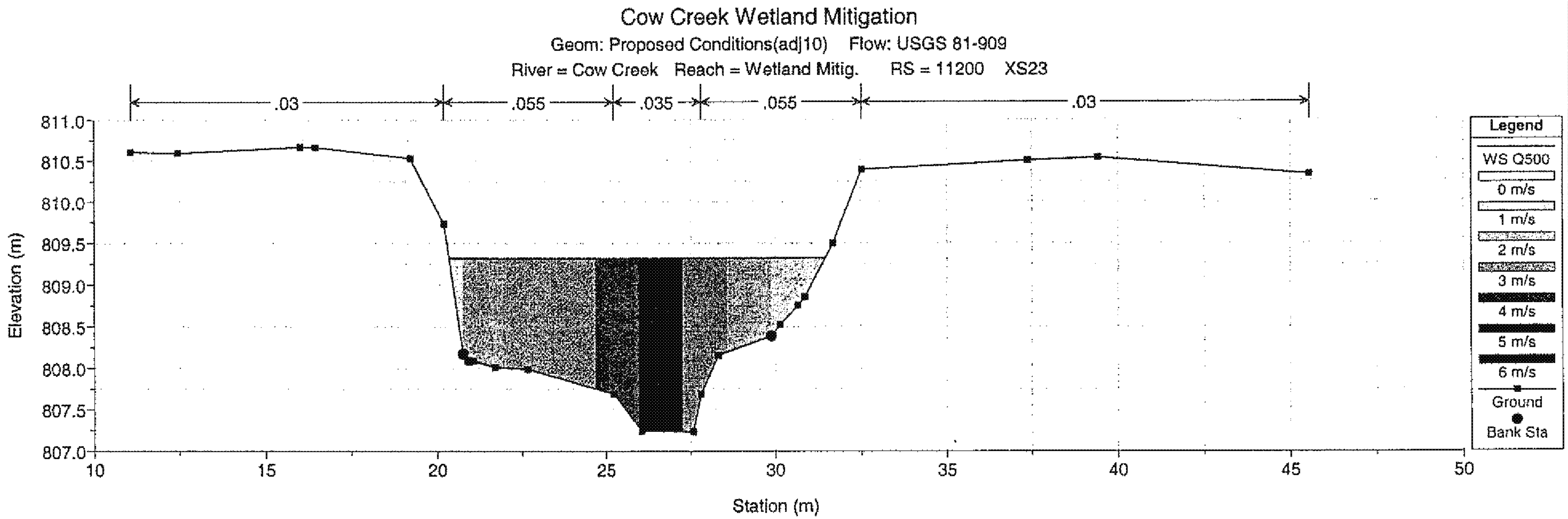


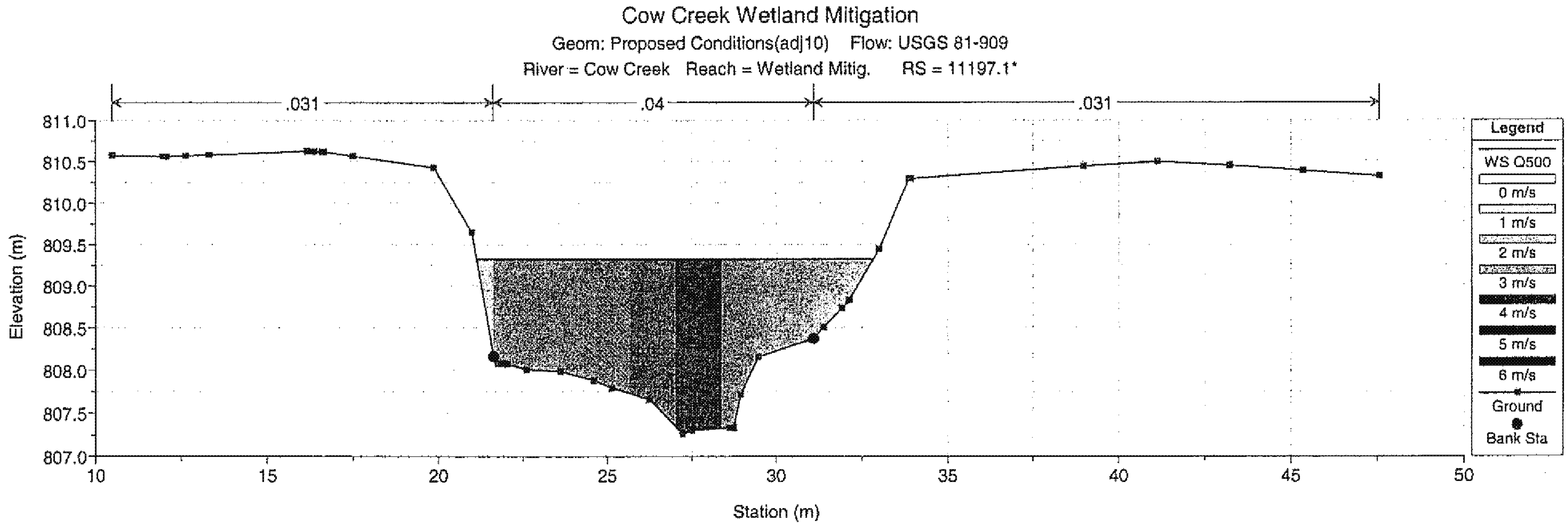
Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10)   Flow: USGS 81-909

River = Cow Creek   Reach = Wetland Mitig.   RS = 11208   BR   Upstream Bridge



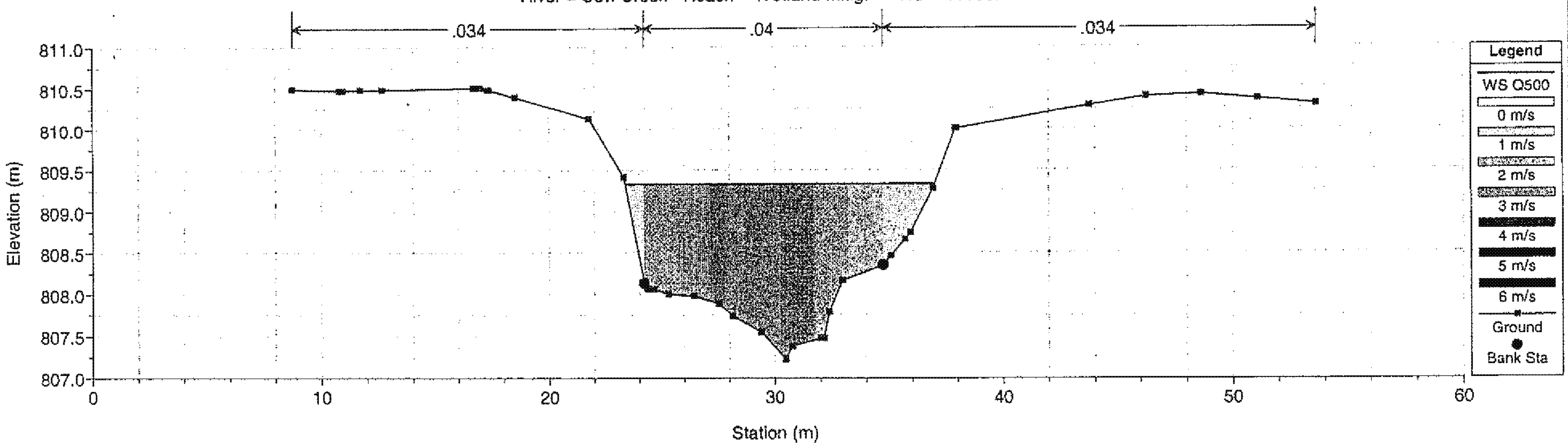

Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11200 XS23
.03
.055
.035
.055
.03
Elevation (m)
811.0
810.5
810.0
809.5
809.0
808.5
808.0
807.5
807.0
10
15
20
25
30
35
40
45
50
Station (m)
Legend
WS Q500
0 m/s
1 m/s
2 m/s
3 m/s
4 m/s
5 m/s
6 m/s
Ground
Bank Sta


Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11197.1*
.031
.04
.031
Elevation (m)
811.0
810.5
810.0
809.5
809.0
808.5
808.0
807.5
807.0
10
15
20
25
30
35
40
45
50
Station (m)
Legend
WS Q500
0 m/s
1 m/s
2 m/s
3 m/s
4 m/s
5 m/s
6 m/s
Ground
Bank Sta

Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10) Flow: USGS 81-909

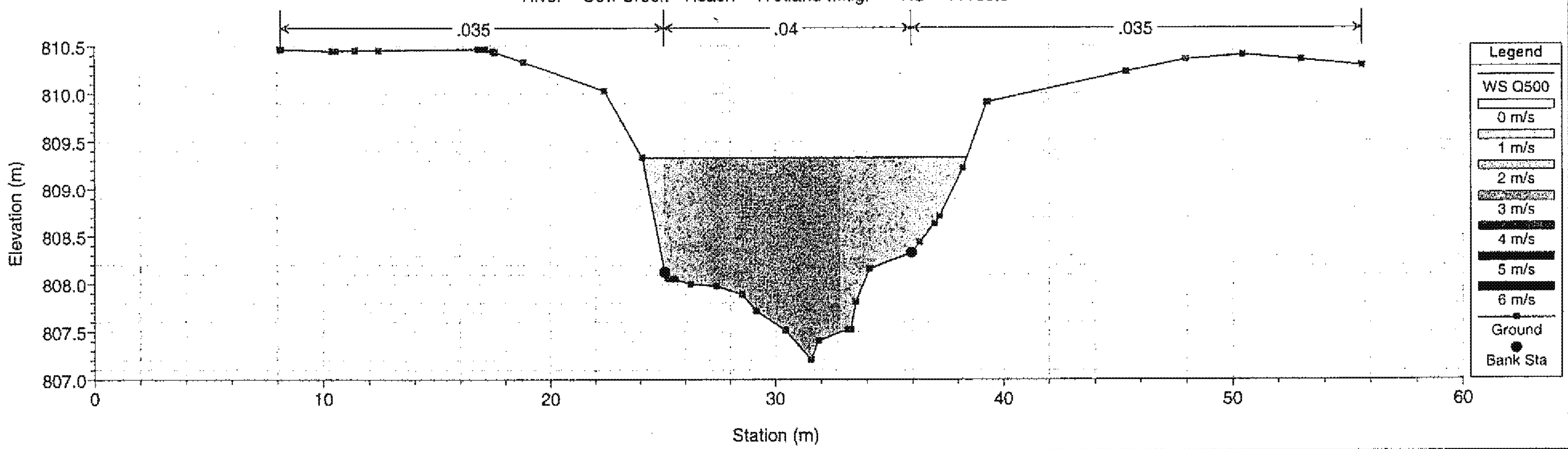
River = Cow Creek Reach = Wetland Mitig. RS = 11188.4*



Cow Creek Wetland Mitigation

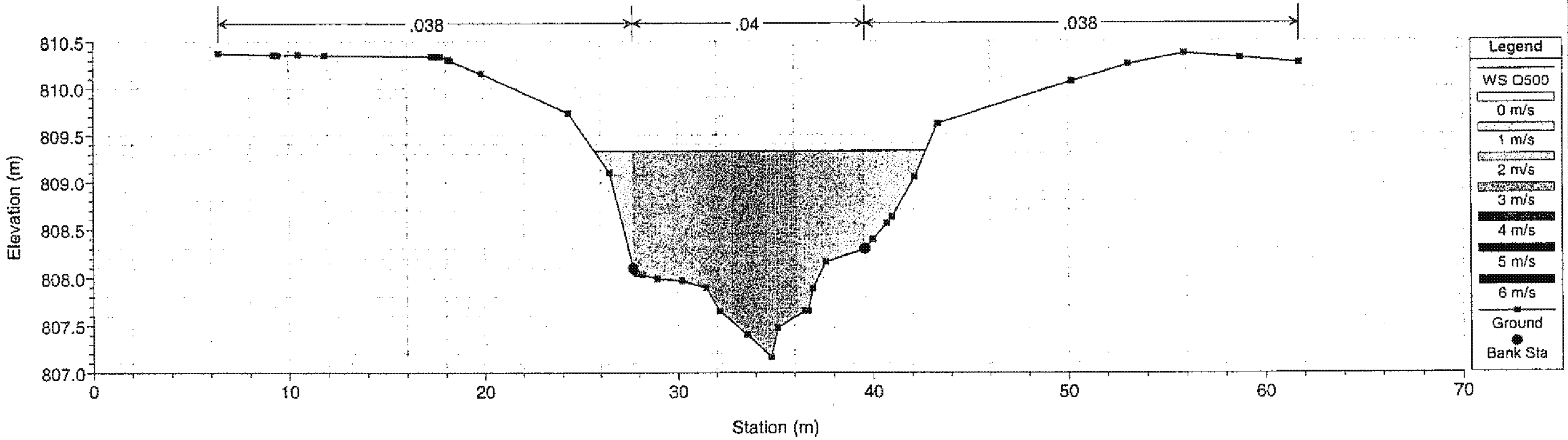
Geom: Proposed Conditions(adj10) Flow: USGS 81-909

River = Cow Creek Reach = Wetland Mitig. RS = 11185.5*



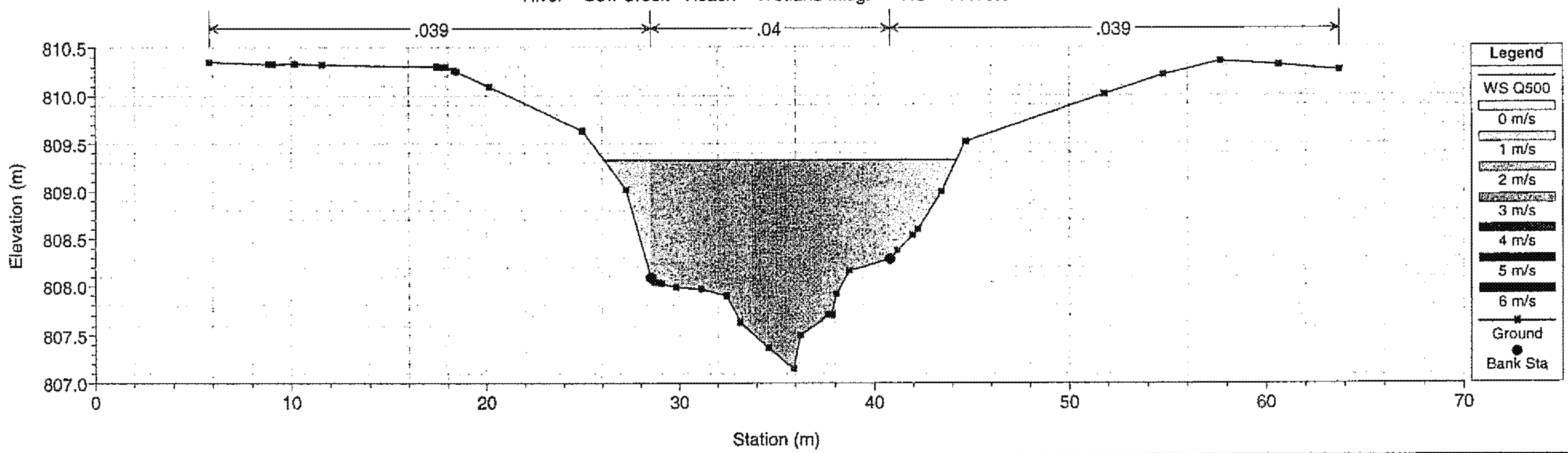
Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11176.8*

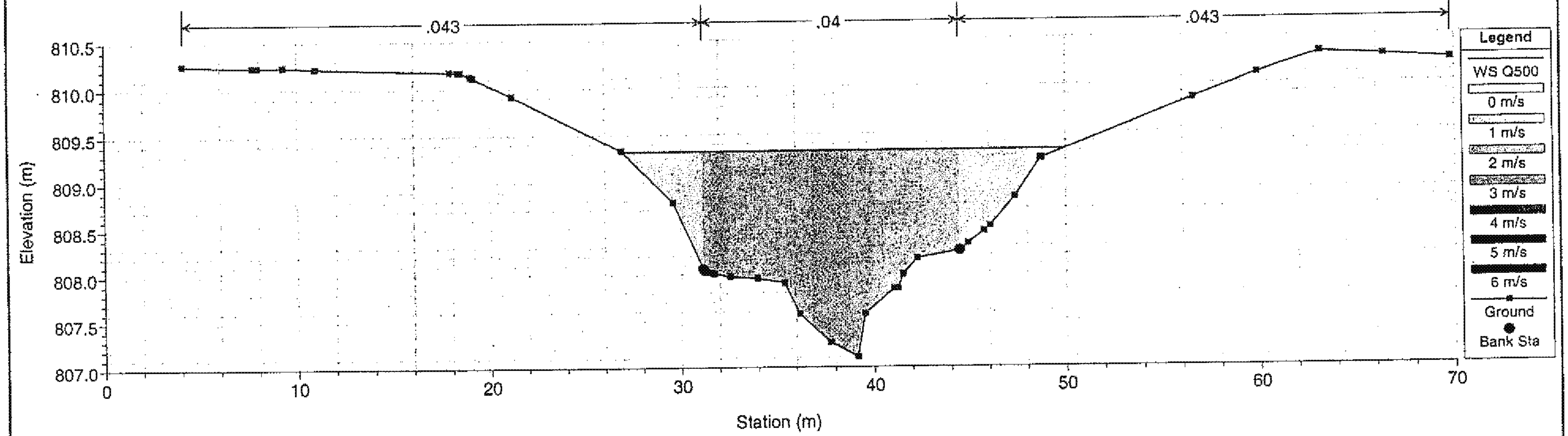


Cow Creek Wetland Mitigation

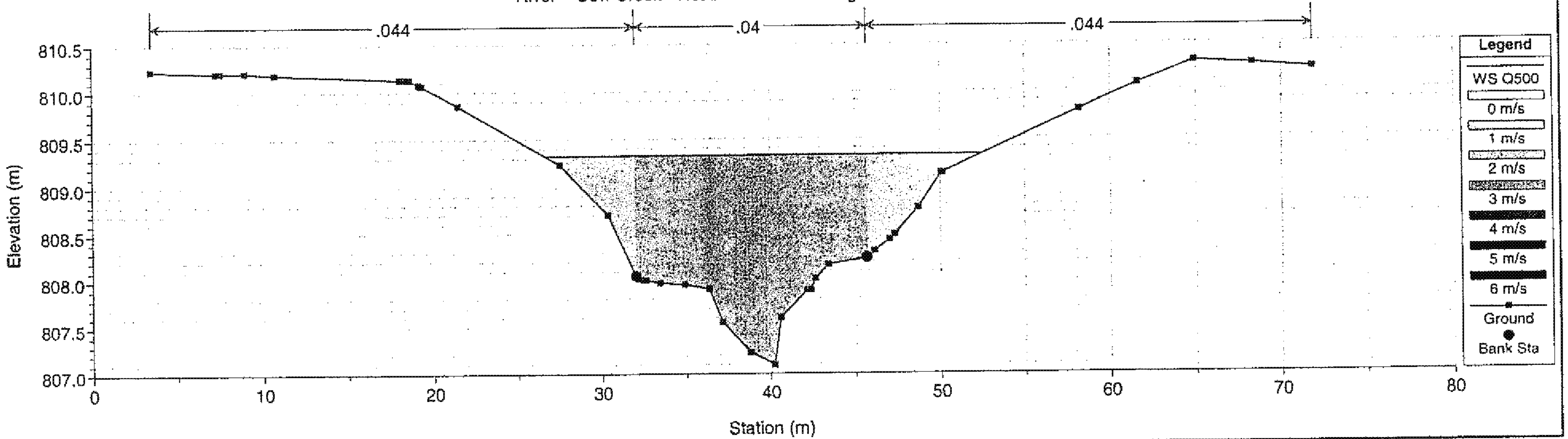
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11173.9*



Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11165.2*



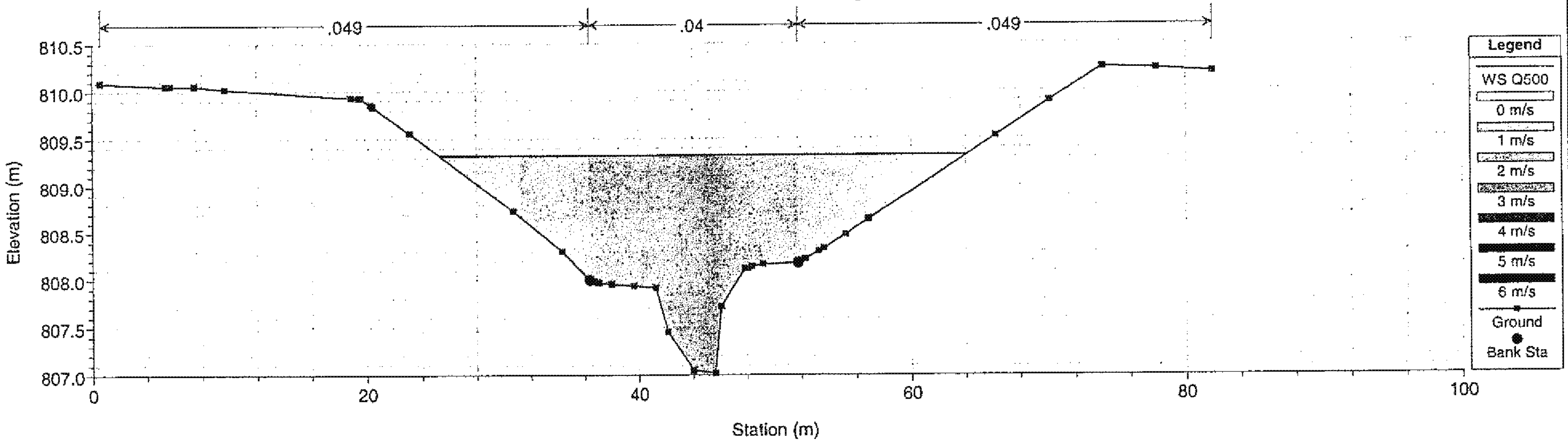
Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 11162.3*



Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10)   Flow: USGS 81-909

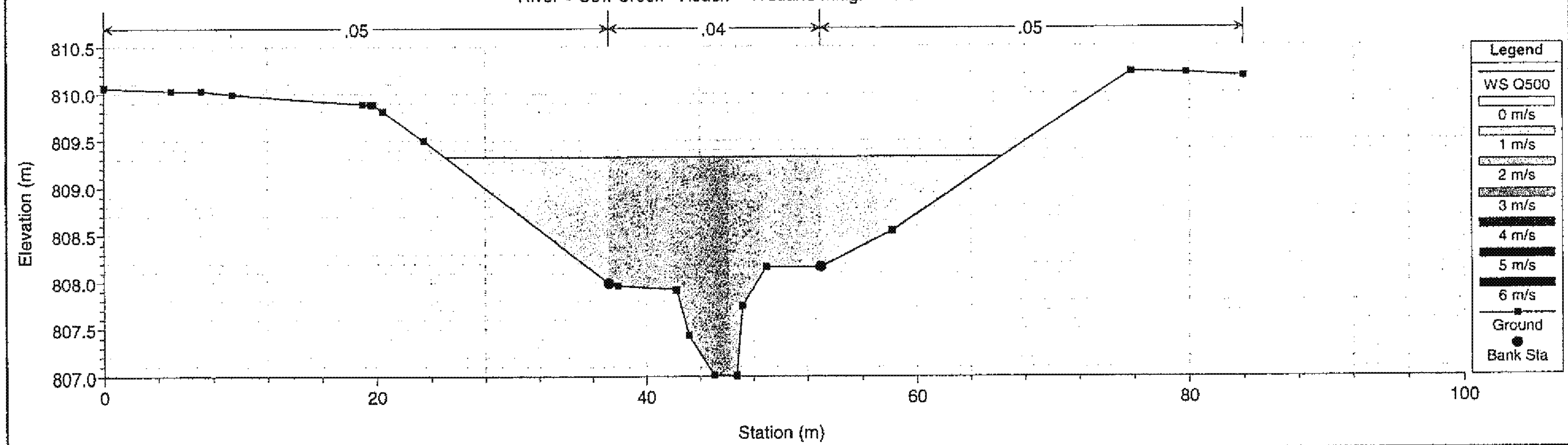
River = Cow Creek   Reach = Wetland Mitig.   RS = 11147.8*



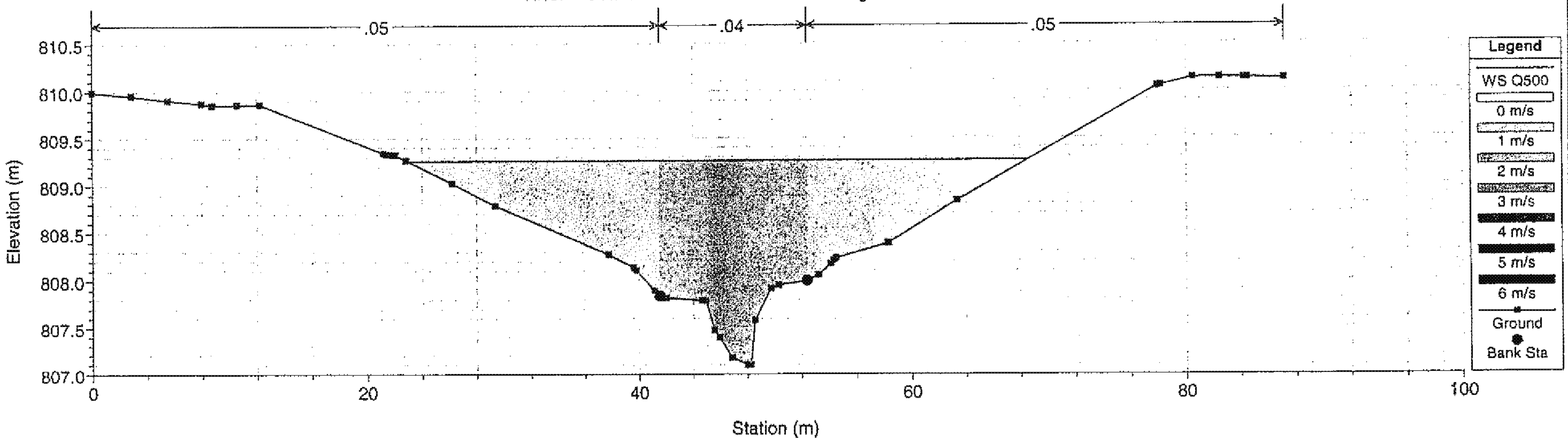
Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10)   Flow: USGS 81-909

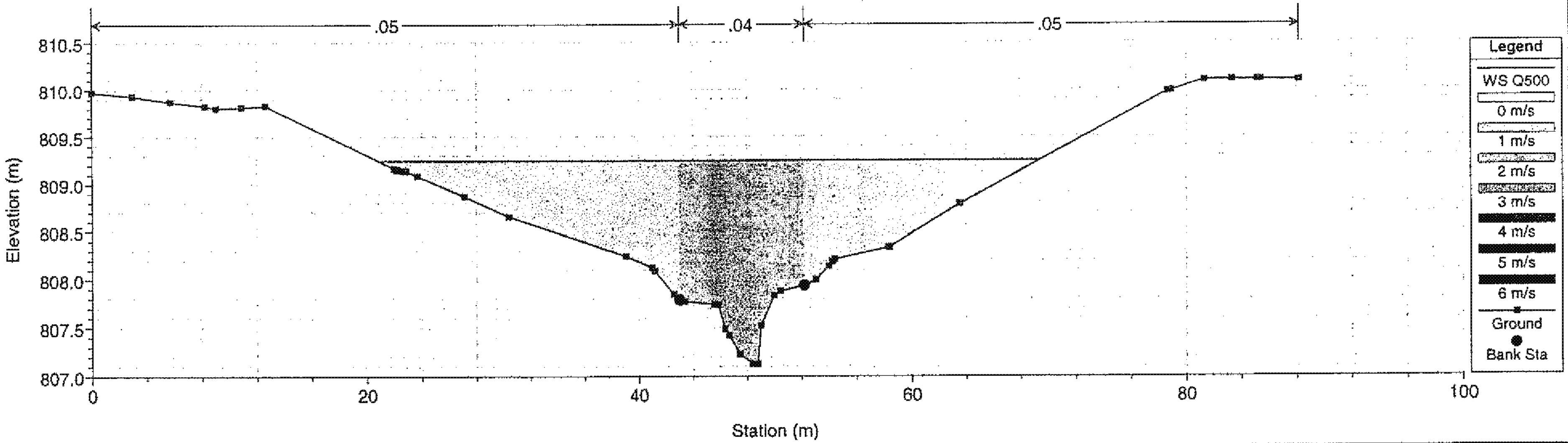
River = Cow Creek   Reach = Wetland Mitig.   RS = 11145   XS21



Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10)   Flow: USGS 81-909
River = Cow Creek   Reach = Wetland Mitig.   RS = 11130.*



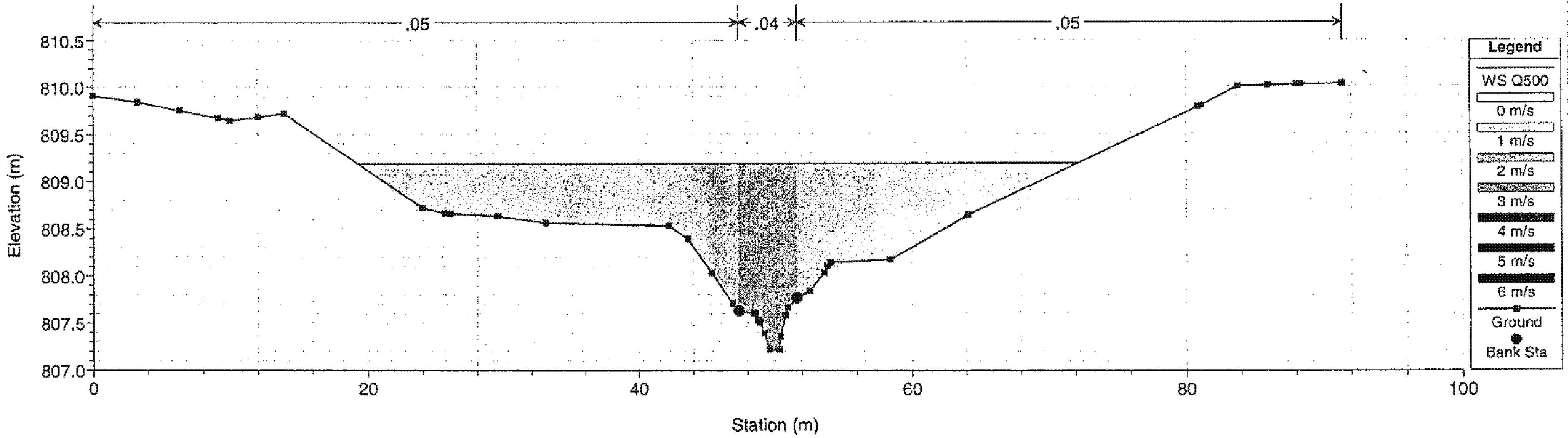
Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10)   Flow: USGS 81-909
River = Cow Creek   Reach = Wetland Mitig.   RS = 11125.*



Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10) Flow: USGS 81-909

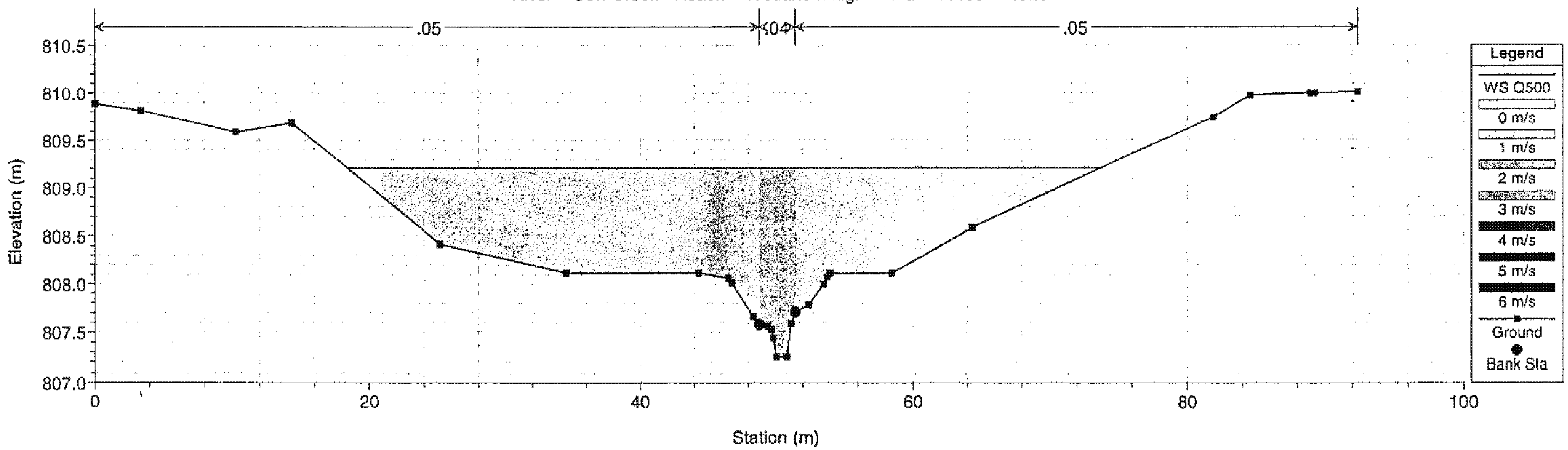
River = Cow Creek Reach = Wetland Mitig. RS = 11110.*

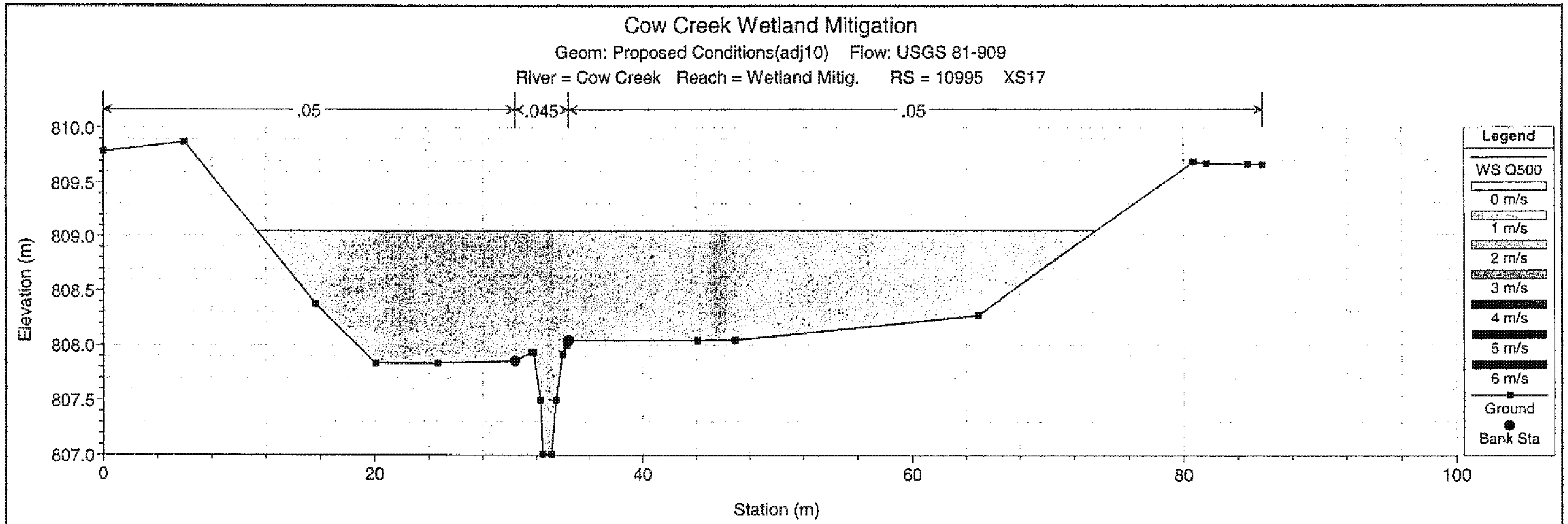


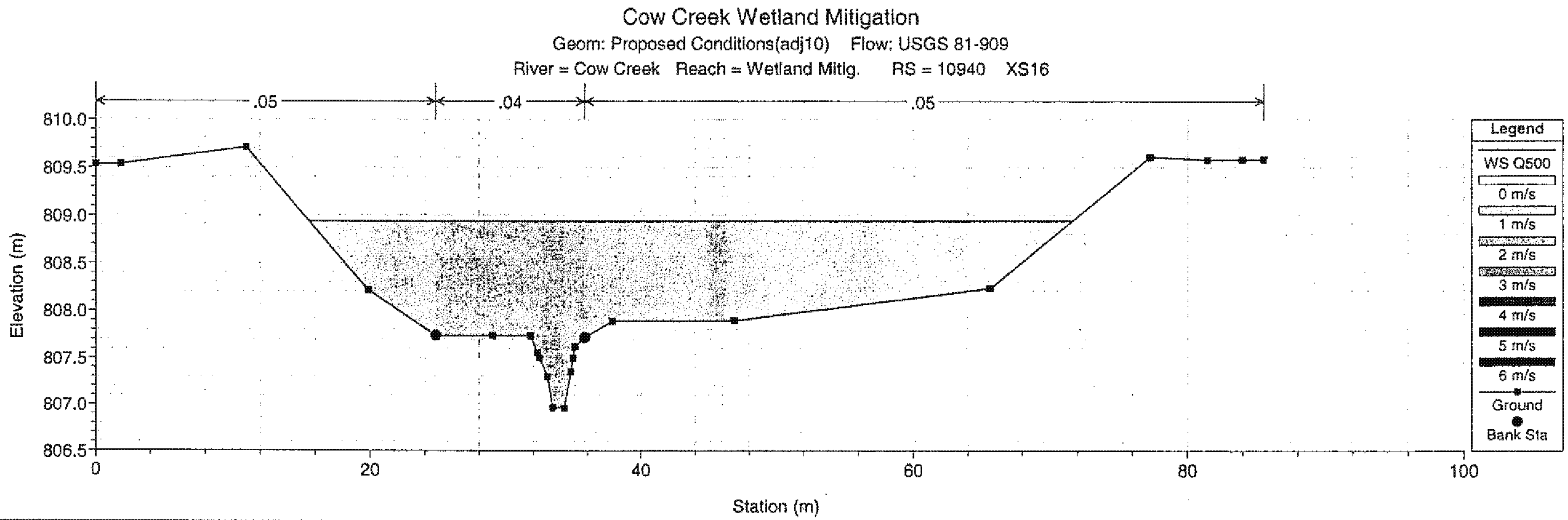
Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10) Flow: USGS 81-909

River = Cow Creek Reach = Wetland Mitig. RS = 11105 XS20



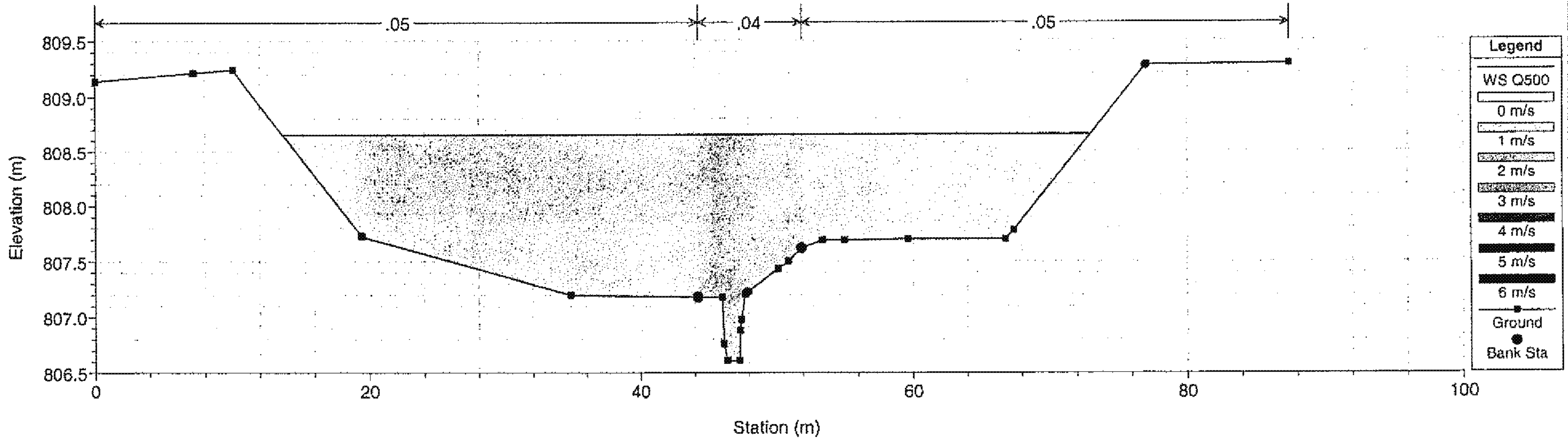

Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10995 XS17
.05
.045
.05
Elevation (m)
Station (m)
Legend
WS Q500
0 m/s
1 m/s
2 m/s
3 m/s
4 m/s
5 m/s
6 m/s
Ground
Bank Sta


Cow Creek Wetland Mitigation
Geom: Proposed Conditions(adj10) Flow: USGS 81-909
River = Cow Creek Reach = Wetland Mitig. RS = 10940 XS16
.05
.04
.05
Elevation (m)
Station (m)
Legend
WS Q500
0 m/s
1 m/s
2 m/s
3 m/s
4 m/s
5 m/s
6 m/s
Ground
Bank Sta

Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10)   Flow: USGS 81-909

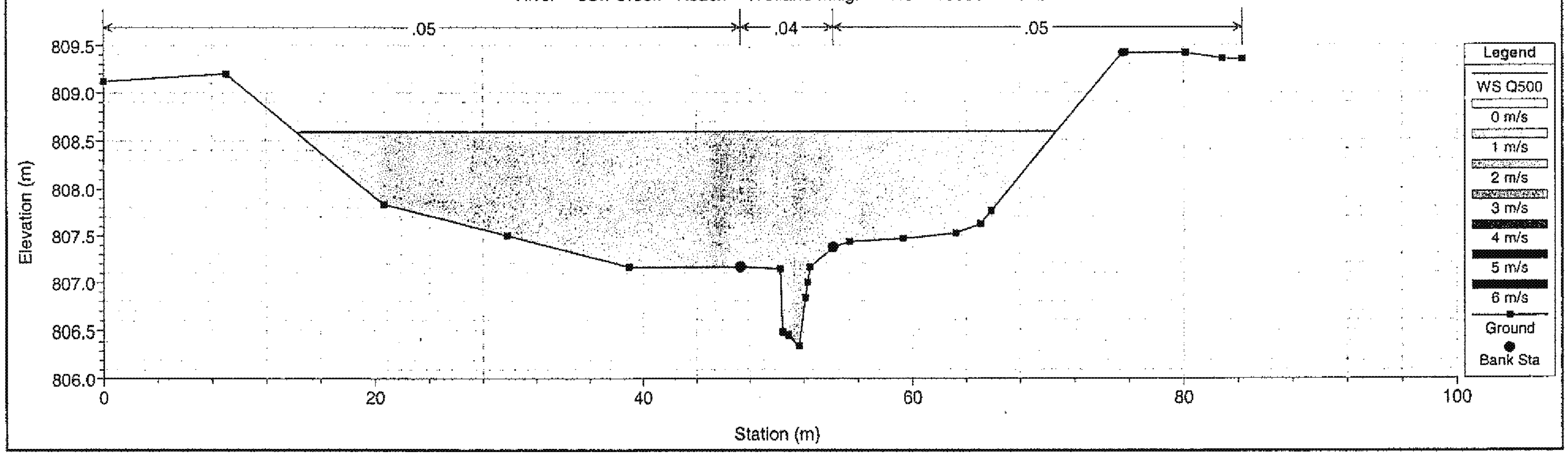
River = Cow Creek   Reach = Wetland Mitig.   RS = 10710   XS13



Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10)   Flow: USGS 81-909

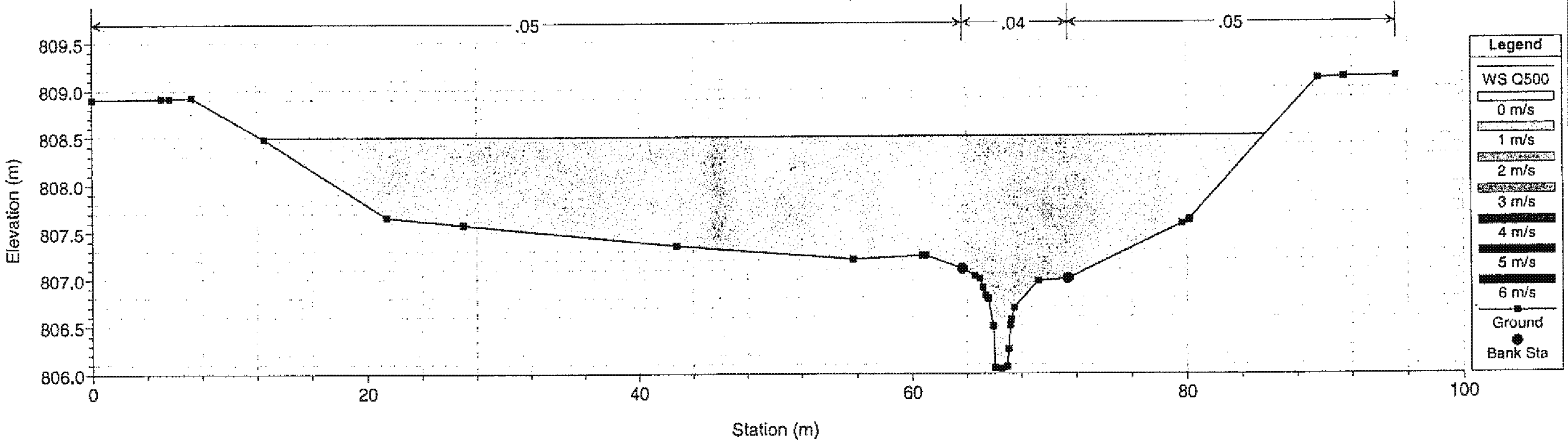
River = Cow Creek   Reach = Wetland Mitig.   RS = 10660   XS12



Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10) Flow: USGS 81-909

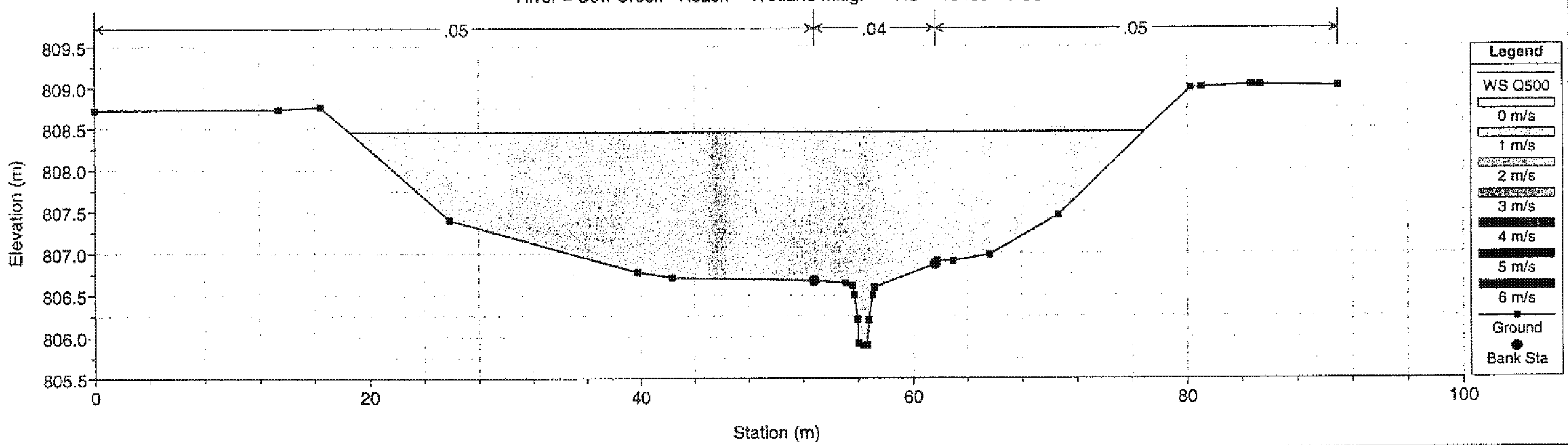
River = Cow Creek Reach = Wetland Mitig. RS = 10555 XS9



Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10) Flow: USGS 81-909

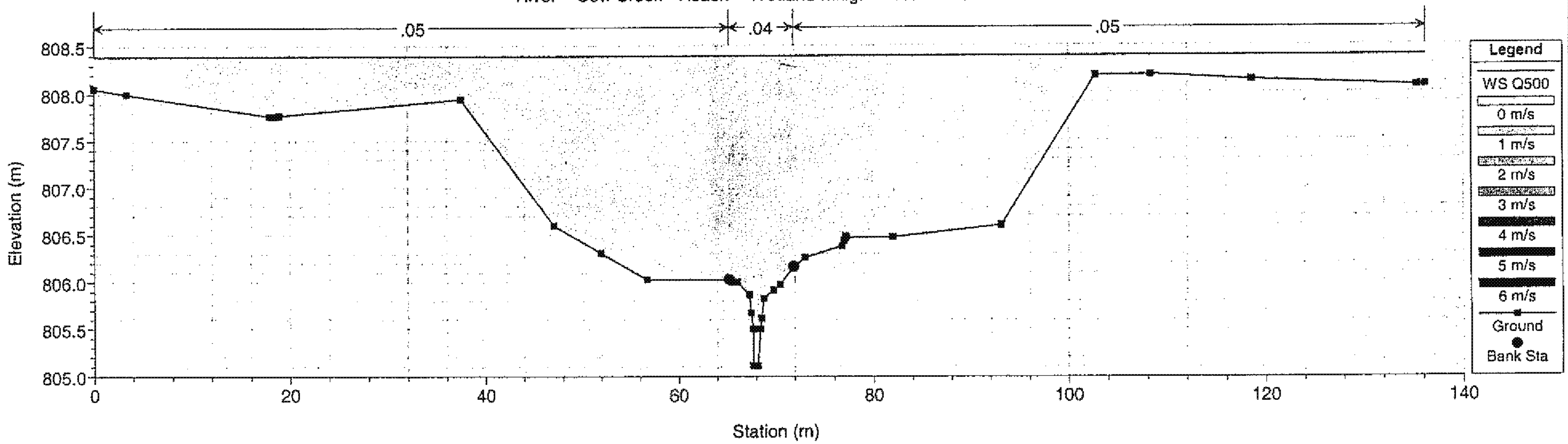
River = Cow Creek Reach = Wetland Mitig. RS = 10480 XS8



Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10) Flow: USGS 81-909

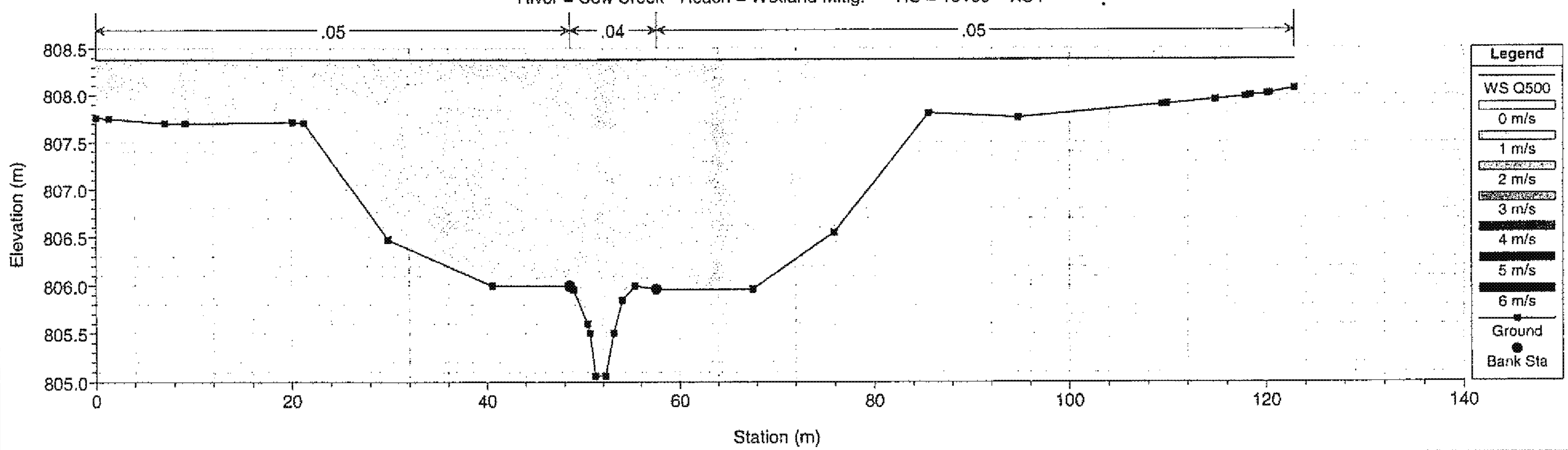
River = Cow Creek Reach = Wetland Mitig. RS = 10240 XS5



Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10) Flow: USGS 81-909

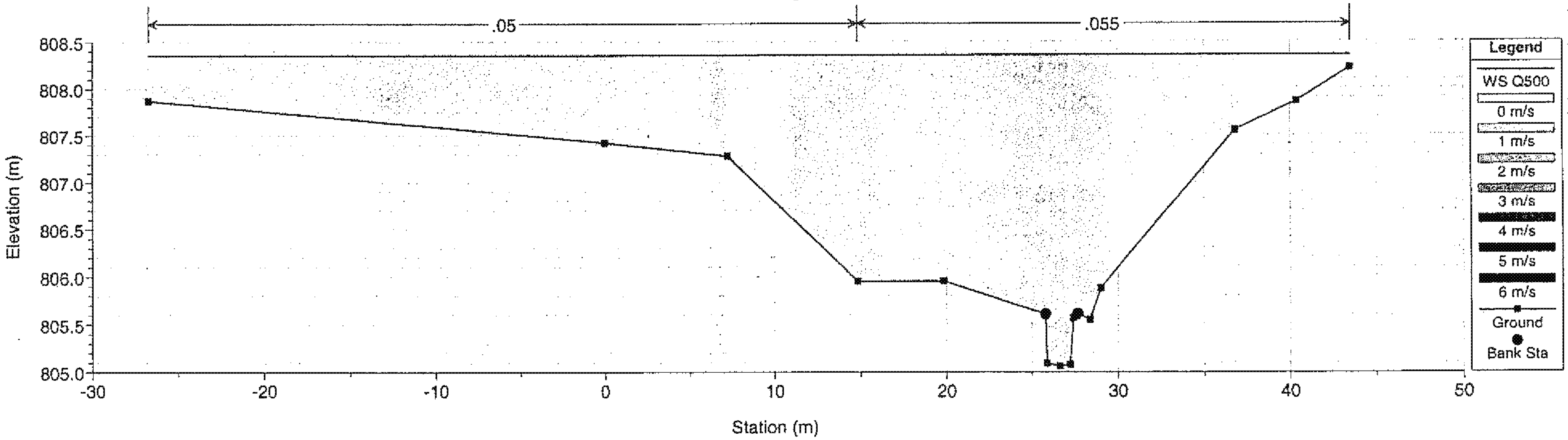
River = Cow Creek Reach = Wetland Mitig. RS = 10160 XS4



Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10)   Flow: USGS 81-909

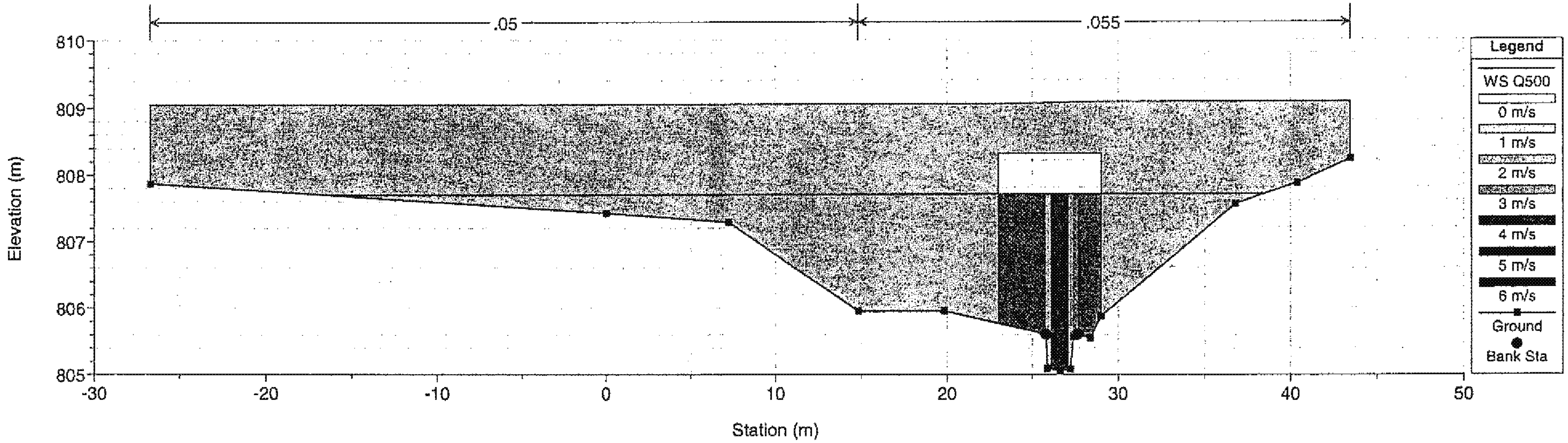
River = Cow Creek   Reach = Wetland Mitig.   RS = 10080   XS3 Above Bridge



Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10)   Flow: USGS 81-909

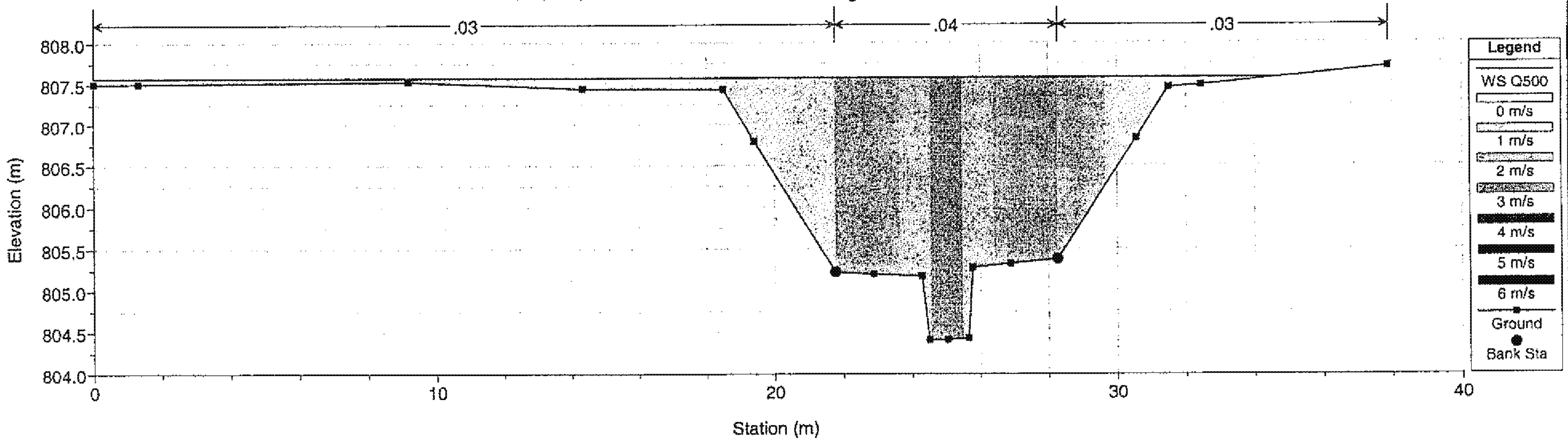
River = Cow Creek   Reach = Wetland Mitig.   RS = 10067   BR   Downstream Bridge



Cow Creek Wetland Mitigation

Geom: Proposed Conditions(adj10) Flow: USGS 81-909

River = Cow Creek Reach = Wetland Mitig. RS = 10020 XS1



APPENDIX C
Review of Hydrologic Data

DAVID EVANS AND ASSOCIATES INC.

INF	D-2	ACT	SIG
✓	DE		
	DTE		
	DME		
	DEP		
	DRI		
	EEO/S/T-C		
	ADE		
	RE-A		
	RE-B		
	DRWS		
✓	BPDE		WEAK.
	DMTCE		
	MTC FRMN		
	ALL SHEDS		
	DSM		
	ALL SUPV		

April 1, 2003

Mr. Dave Ellis
Idaho Transportation Department
PO Box 837
Lewiston, Idaho 83501

Subject: Two and Three Year Flows for Cow Creek, Nez Perce County, Idaho
US 95 Top of Lewiston Hill to Genesee
NH-4110(133), Key No. 7769

Dear Dave,

As requested by Entranco, and authorized by ITD, David Evans and Associates, Inc. (DEA) has developed annual peak discharges for the 2- and 3-year recurrence intervals, for Cow Creek near the city of Genesee, Idaho. The calculated flows are 341 cfs (9.6 m^3/sec) and 426 cfs (m^3/sec), respectively. These flows are intended to aid you with the design of a wetland mitigation site just upstream of US 95.

Per ITD hydrologic standards, *U.S.G.S. Open File Report 81-909 A Method for Estimating Flood-Frequency Parameters for Streams in Idaho* was used to determine the flows. As a crosscheck, peak flows were generated by a second hydrologic method, *U.S.G.S. Water-Resource Investigation 7-73 Magnitude and Frequency of Floods in Small Drainage Basins in Idaho*. Agreement between the two methods was excellent for the 25- and 50-year flows, which tends to increase confidence in the 2- and 3-year results produced by OFR 81-909. See the attached spreadsheets for data and calculations.

The size of the Cow Creek basin feeding the proposed wetland mitigation site is approximately 36.5 square miles, or 23,360 acres, based on the 15 minute U.S.G.S. topographical map. See the attached map for an illustration of the basin. As is typical of the Palouse region, virtually none of the basin is treed. Also, to the best of our knowledge there are no significant diversions into or out of the creek upstream of the mitigation site. The sewage lagoons for the city of Genesee contribute a small amount of effluent to the creek during the winter, but the flows are insignificant in comparison to the peak flow values.

Please let me know if you have any additional questions, or need any additional hydrologic or hydraulic data to assist you in the design of the wetland mitigation site.

Sincerely,

DAVID EVANS AND ASSOCIATES, INC.

Douglas W. Busko

Douglas W. Busko, P.E.
Civil Engineer

PROFESSIONAL ENGINEER
REGISTERED
9531
4-1-03
STATE OF IDAHO
DOUGLAS W. BUSKO

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APR 03 2003
DIV. OF HIGHWAYS
LEWISTON, IDAHO

Enclosures

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K/ELLIS-040103.doc

Regionalized Regression Equations for Annual Maximum Discharges

A Method for Estimating Flood-Frequency Parameters for Streams in Idaho

U.S.G.S., Open-File Report 81-909

US 95, Top of Lewiston Hill to Genesee

ITD Project No. NH-4110(133), Key No. 7769

(1) Basin	Station	Area (acres)	Area (mi²)	(2) Slope of channel (ft/mi)	Mean annual precipitation (in)	Mean altitude of basin (ft)	(3) Skew coefficient, G	Storm recurrence interval	Exceedance probability, P_e	(4) Mean log, M	(5) Standard Deviation, S	(6) K_{Pe}	(7) Log Q	Q (cfs)	Q (m³/s)
Cow Creek	Proposed Mitigation Wetland	23,360	36.50	13	16	2,800	0.2	2	0.50	2.540	0.222	-0.03325	2.532	341	9.6
								3	0.33			0.40674	2.630	426	12.1
								25	0.04			1.81756	2.942	876	24.8
								50	0.02			2.15935	3.018	1,043	29.5
								100	0.01			2.47226	3.088	1,223	34.6
								500	0.002			3.12169	3.231	1,704	48.2

(1) Basin is located in Region 3, as shown in Figure 6 of Open-File Report 81-909
(2) 114 ft elevation drop in 8.8 miles of main channel
(3) Figure D-17 of Open-File Report 81-909
(4) M=0.800+0.993(log(area))+0.169(log(slope))
(5) S=0.751-0.050(log(area))-0.111(log(altitude))-0.057(log(mean annual precipitation))
(6) From Data Table 'F' of Open-File Report 81-909
(7) Log Q_{Pe}=M+K_{Pe}S

October 1, 2003

Mr. Dale Anderson
Entranco
10900 NE 8th Street, Suite 300
Bellevue, WA 98004-4405

Subject: Review of Flood Magnitude-Frequency Estimates for Cow Creek, US 95 Top of Lewiston Hill to Genesee Project

Dear Mr. Anderson:

This letter summarizes my review of magnitude-frequency estimates for Cow Creek at US 95 performed by David Evans and Associates[1] (DEA). The work by DEA was performed to identify the 2-year and 3-year flood peak discharge rates for use in the design of a wetland mitigation site upstream of the US 95 crossing of Cow Creek in western Idaho. Field observations of the Cow Creek stream channel by Entranco staff revealed that the discharge estimates provided by DEA appeared high relative to the size of the stream channel. The purpose of this review was to verify DEA's flood-frequency results for the Cow Creek watershed and make recommendations to refine the estimates if warranted.

Streamflow data were not available near the wetland mitigation site and DEA utilized regression relationships to estimate peak discharge rates based on watershed characteristics. The regression relationships were developed by the US Geological Survey and published in USGS Open File Report 81-909[2], which is contained in the Idaho Transportation Department Roadway Design Manual[3]. A review of the calculations performed by DEA showed that the USGS regression equations were correctly applied (assuming watershed characteristics were correctly determined) and the 2-year and 3-year discharge estimates are valid according to the regression methodology. Attached are calculations verifying DEA's flood-frequency values. Standard error of estimate was not provided in OFR 81-909, which made it impossible to develop confidence limits for the predicted magnitude-frequency values.

Regression equations developed by the USGS for Washington State (USGS OFR 74-336[5]) were also used to estimate flood frequency values for the Cow Creek watershed (attached). Equations were used for Washington State Region XI, which includes the Palouse River, to which Cow Creek is a tributary. This approach resulted in similar discharge estimates as OFR 81-909 for common floods (5-year recurrence interval) and significantly higher estimates for floods more rare than the 5-year recurrence interval (see attached graph).

USGS Open File Report 81-909
Cow Creek ID

Area Sq Mi	Channel Slope ft/mi	MAP (inches)	Mean Elev (ft)	Regional Skew	Recurrence Interval (yrs)	Exceedance Probability	Mean Log M	Stdev Log S	K	Log Q	Q (cfs)
36.5	13	**24**	2800	0.2	1.01	0.990	2.540	0.212	-2.182	2.078	120
					2	0.500			-0.033	2.533	341
					3	0.333			0.403	2.625	422
					5	0.200			0.830	2.715	519
					10 .	0.100			1.301	2.815	653
					25	0.040			1.818	2.924	840
					50	0.020			2.160	2.997	992
					100	0.010			2.473	3.063	1156
					500	0.002			3.123	3.200	1586

Note: Mean annual precipitation (MAP) changed from that used by DEA, however, this resulted in negligible change to the flood frequency values.

September 29, 2003

From USGS OFTR 74-336

Cow Creek Id

Basin Area	36.5 Mi^2
MAP	24 inches
% Forest	10

Q=aAPF

Cum P	Tr	a	A Expon	P Expon	F Expon	S	Q (cfs)
0.8	5	0.450	0.9	1.35	-0.21	63%	516
0.9	10	1.360	0.88	1.16	-0.23	64%	758
0.96	25	3.590	0.87	1.03	-0.25	72%	1219
0.98	50	6.610	0.86	0.95	-0.27	81%	1603
0.99	100	11.500	0.85	0.89	-0.29	92%	2123

APPENDIX D

U.S. Army Corps of Engineers' Wetland Mitigation Checklist

MITIGATION PLAN KEY ELEMENTS

February 14, 2003

(Based on Regulatory Guidance Letter 02-2)

Note: Corps districts will determine the appropriate level of mitigation based on the functions lost or adversely affected as a result of impacts to aquatic resources.

1. Baseline Information (for both impact and mitigation sites)
   - Description of resource (location)
   - Acreage and type of aquatic resource
     - Functions and values
     - Temporary v. permanent impacts
   - Drawing, delineation or reference site
   - Baseline data (species, coverage, hydrology)

2. Mitigation Goals and Objectives
   - Number of acres and aquatic resource type to be provided
     - Existing and proposed elevations for excavation
     - Functions and values proposed and how they compensate for project impacts (resource comparison of gains/losses)
     - Specify if mitigation is permanent or temporary

3. Mitigation Construction Plan

   - Responsible party

   - Construction boundaries, methods, elevation and slope of the mitigation area, timing (generally needs to be concurrent with authorized impacts), sequence for implementation in relation to project impacts, complete date

   - Vegetation: planting plans, native vegetation proposed for planting, location, where, how many, percent cover, buffers to protect the mitigation site, plans to control exotic invasive species, etc.

   - Soils: excavation, grading, proposed substrate composition, import hydric soil from impact site, erosion control

   - Hydrology: source of water supply, anticipated hydrologic regime, how it will be maintained

   - Stream or open water geomorphology

4. Long-term Protection
   - Conservation easement (deed restriction is less desirable)
   - Maintenance plan (how it will be maintained after built)
   - Responsible party

5. Monitoring Plan (Normally 5-10 years)
   - Schedule and responsible party
   - Reporting requirements
   - Methods and information collected
   - Comparison with performance standards
   - Recommended changes (replanting, etc.)
   - Photos

6. Performance Standards (checklist used to determine compliance and success of the mitigation

1. **Establishment (Creation):** The manipulation of the physical, chemical, or biological characteristics present to develop a wetland on an upland or deepwater site, where a wetland did not previously exist. Establishment results in a gain in wetland acres.

2. **Restoration:** The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural or historic functions to a former or degraded wetland. For the purpose of tracking net gains in wetland acres, restoration is divided into:

a.) **Re-establishment:** The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural or historic functions to a former wetland. Re-establishment results in rebuilding a former wetland and results in a gain in wetland acres.

b.) **Rehabilitation:** The manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural or historic functions of a degraded wetland. Rehabilitation results in a gain in wetland function but does not result in a gain in wetland acres.

3. **Enhancement:** The manipulation of the physical, chemical, or biological characteristics of a wetland (undisturbed or degraded) site to heighten, intensify, or improve specific function(s) or to change the growth stage or composition of the vegetation present. Enhancement is undertaken for specified purposes such as water quality improvement, flood water retention, or wildlife habitat. Enhancement results in a change in wetland function(s) and can lead to a decline in other wetland functions, but does not result in a gain in wetland acres. This term includes activities commonly associated with enhancement, management, manipulation, and directed alteration.

4. **Protection/Maintenance (Preservation):** The removal of a threat to, or preventing the decline of, wetland conditions by an action in or near a wetland. This term includes the purchase of land or easements, repairing water control structures or fences, or structural protection such as repairing a barrier island. This term also includes activities commonly associated with the term preservation. Preservation does not result in a gain of wetland acres and will be used only in exceptional circumstances.

f. **Preservation Credit:** Districts may give compensatory mitigation credit when existing wetlands, or other aquatic resources are preserved in conjunction with establishment, restoration, and enhancement activities. However, Districts should only consider credit when the preserved resources will augment the functions of newly established, restored, or enhanced aquatic resources. Such augmentation may be reflected in the amount of credit attributed to the entire mitigation project. In exceptional circumstances, the preservation of existing wetlands or other aquatic resources may be authorized as the sole basis for generating credits as mitigation projects. Natural wetlands provide numerous ecological benefits that restored wetlands cannot provide immediately and may provide more practicable long-term ecological benefits. If preservation alone is proposed as mitigation, Districts will consider whether the wetlands or other aquatic resources: 1) perform

b. General Permits: For activities authorized by general permits, Districts may recommend consolidated compensatory mitigation projects such as mitigation banks and in-lieu fee programs where such sources of compensatory mitigation are available. Consolidated mitigation facilitates a watershed approach to mitigating impacts to waters of the United States. For regional general permits associated with Special Area Management Plans or other types of watershed plans, the District may also recommend the use of mitigation banks or in-lieu-fee arrangements, consistent with the guidance for those forms of compensation.

3. Compensatory Mitigation Plans: Districts will strive to discuss compensatory mitigation proposals with applicants during pre-application consultation. If this does not occur, the scope and specificity of proposed compensatory mitigation plans merely represent the applicant's view of what is necessary, a view that may not be acceptable to the Corps or other governmental authorities. At the earliest opportunity, Districts will advise applicants of the mitigation sequencing requirements of the Section 404(b)(1) Guidelines, or what is required for general permits. Compensation is the last step in the sequencing requirements of the Section 404 (b)(1) Guidelines. Thus, for standard permit applications, Districts should not require detailed compensatory mitigation plans until they have established the unavoidable impact. In all circumstances, the level of information provided regarding mitigation should be commensurate with the potential impact to aquatic resources, consistent with the guidance from Regulatory Guidance Letter 93-2 on the appropriate level of analysis for compliance with the Section 404 (b)(1) Guidelines. Districts will identify for applicants the pertinent factors for this determination (e.g., watershed considerations, local or state requirements, uncertainty, out-of-kind compensation, protection and maintenance requirements, etc.). Districts also will identify for applicants the rationale to be used (e.g., best professional judgment, Hydrogeomorphic Assessment Method, Wetland Rapid Assessment Procedure, etc.) for determining allowable impact and required compensatory mitigation. Applicants will be encouraged to submit appropriate compensatory mitigation proposals with individual permit applications or general permit pre-construction notices. The components listed below form the basis for development of compensatory mitigation plans.

a. Baseline Information: As part of the permit decision Districts will include approved, written compensatory mitigation plans describing the location, size, type, functions and amount of impact to aquatic and other resources, as well as the resources in the mitigation project. In addition, they should describe the size, e.g., acreage of wetlands, length and width of streams, elevations of existing ground at the mitigation site, historic and existing hydrology, stream substrate and soil conditions, and timing of the mitigation. Baseline information may include quantitative sampling data on the physical, chemical, and biological characteristics of the aquatic resources at both the proposed mitigation site and the impact site. This documentation will support the compensatory mitigation requirement.

b. Goals and Objectives: Compensatory mitigation plans should discuss environmental goals and objectives, the aquatic resource type(s), e.g., hydrogeomorphic (HGM) regional wetland subclass, Rosgen stream type, Cowardin classification, and functions that will be impacted by the authorized work, and the aquatic resource type(s) and functions proposed at the compensatory will require monitoring plans with a reporting frequency sufficient for an inspector to determine compliance with performance standards and to identify remedial action. Monitoring will be required for an adequate period of time, normally 5 to 10 years, to ensure the project meets performance standards. Corps permits will require permanent compensatory mitigation unless otherwise noted in the special conditions of the permit. Districts may take enforcement action even after the identified monitoring period, if there has been a violation.

j. **Financial Assurances:** Compensatory mitigation plans will identify the party responsible for providing and managing any financial assurances and contingency funds set aside for remedial measures to ensure mitigation success. This includes identifying the party that will provide for long-term management and protection of the mitigation project. Financial assurances should be commensurate with the level of impact and the level of compensatory mitigation required. Permit conditions for minimal and low impact projects are generally sufficient for enforcing performance standards and requiring compliance, without the requirement of additional financial assurances. Financial assurances should be sufficient to cover contingency actions such as a default by the responsible party, or a failure to meet performance standards. District Engineers will generally emphasize financial assurances when the authorized impacts occur prior to successful completion of the mitigation, to include the monitoring period. Financial assurances may be in the form of performance bonds, irrevocable trusts, escrow accounts, casualty insurance, letters of credit, legislatively enacted dedicated funds for government operated banks or other approved instruments. Such assurances may be phased-out or reduced, once the project has been demonstrated functionally mature and self-sustaining in accordance with performance standards.

Financial assurances for third party mitigation should be consistent with existing guidance (e.g., Federal Guidance for the Establishment, Use and Operation of Mitigation Banks, and the Federal Guidance on the Use of In-Lieu-Fee Arrangements for Compensatory Mitigation under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act). The District will determine project success, and the need to use financial assurances to carry out remedial measures, in accordance with the project performance standards.

4. __Duration__. This guidance remains effective unless revised or rescinded.

FOR THE COMMANDER:

for Michael J. Walsh US Army Col.

Encl

ROBERT H. GRIFFIN
Major General, U.S. Army
Director of Civil Works

whenever feasible, use natural recruitment sources for more resilient vegetation establishment. Some systems, especially estuarine wetlands, are rapidly colonized, and natural recruitment is often equivalent or superior to plantings (Dawe et al. 2000). Try to take advantage of native seed banks, and use soil and plant material salvage whenever possible. Consider planting mature plants as supplemental rather than required, with the decision depending on early results from natural recruitment and invasive species occurrence. Evaluate on-site and nearby seed banks to ascertain their viability and response to hydrological conditions. When plant introduction is necessary to promote soil stability and prevent invasive species, the vegetation selected must be appropriate to the site rather than forced to fit external pressures for an ancillary purpose (e.g., preferred wildlife food source or habitat).

6. *Pay particular attention to appropriate planting elevation, depth, soil type, and seasonal timing.* When the introduction of species is necessary, select appropriate genotypes. Genetic differences within species can affect wetland restoration outcomes, as found by Seliskar (1995), who planted cordgrass (*Spartina alterniflora*) from Georgia, Delaware, and Massachusetts into a tidal wetland restoration site in Delaware. Different genotypes displayed differences in stem density, stem height, below-ground biomass, rooting depth, decomposition rate, and carbohydrate allocation. Beneath the plantings, there were differences in edaphic chlorophyll and invertebrates.

Many sites are deemed compliant once the vegetation community becomes established. If a site is still being irrigated or recently stopped being irrigated, the vegetation might not survive. In other cases, plants that are dependent on surface-water input might not have developed deep root systems. When the surface-water input is stopped, the plants decline and eventually die, leaving the mitigation site in poor condition after the Corps has certified the project as compliant.

7. *Provide appropriately heterogeneous topography.* The need to promote specific hydroperiods to support specific wetland plants and animals means that appropriate elevations and topographic variations must be present in restoration and creation sites. Slight differences in topography (e.g., micro- and meso-scale variations and presence and absence of drainage connections) can alter the timing, frequency, amplitude, and duration of inundation. In the case of some less-studied, restored wetland types, there is little scientific or technical information on natural microtopography (e.g., what causes strings and flarks in patterned fens or how hummocks in fens control local nutrient dynamics and species assemblages and subsurface hydrology are poorly known). In all cases, but especially those with minimal scientific and technical background, the proposed development wetland or appropriate example(s) of the target wetland type should provide a model template for incorporating microtopography.

Plan for elevations that are appropriate to plant and animal communities that are reflected in adjacent or close-by natural systems. In tidal systems, be aware of local variations in tidal flooding regime (e.g., due to freshwater flow and local controls on circulation) that might affect flooding duration and frequency.

8. *Pay attention to subsurface conditions, including soil and sediment geochemistry and physics, groundwater quantity and quality, and infaunal communities.* Inspect and characterize the